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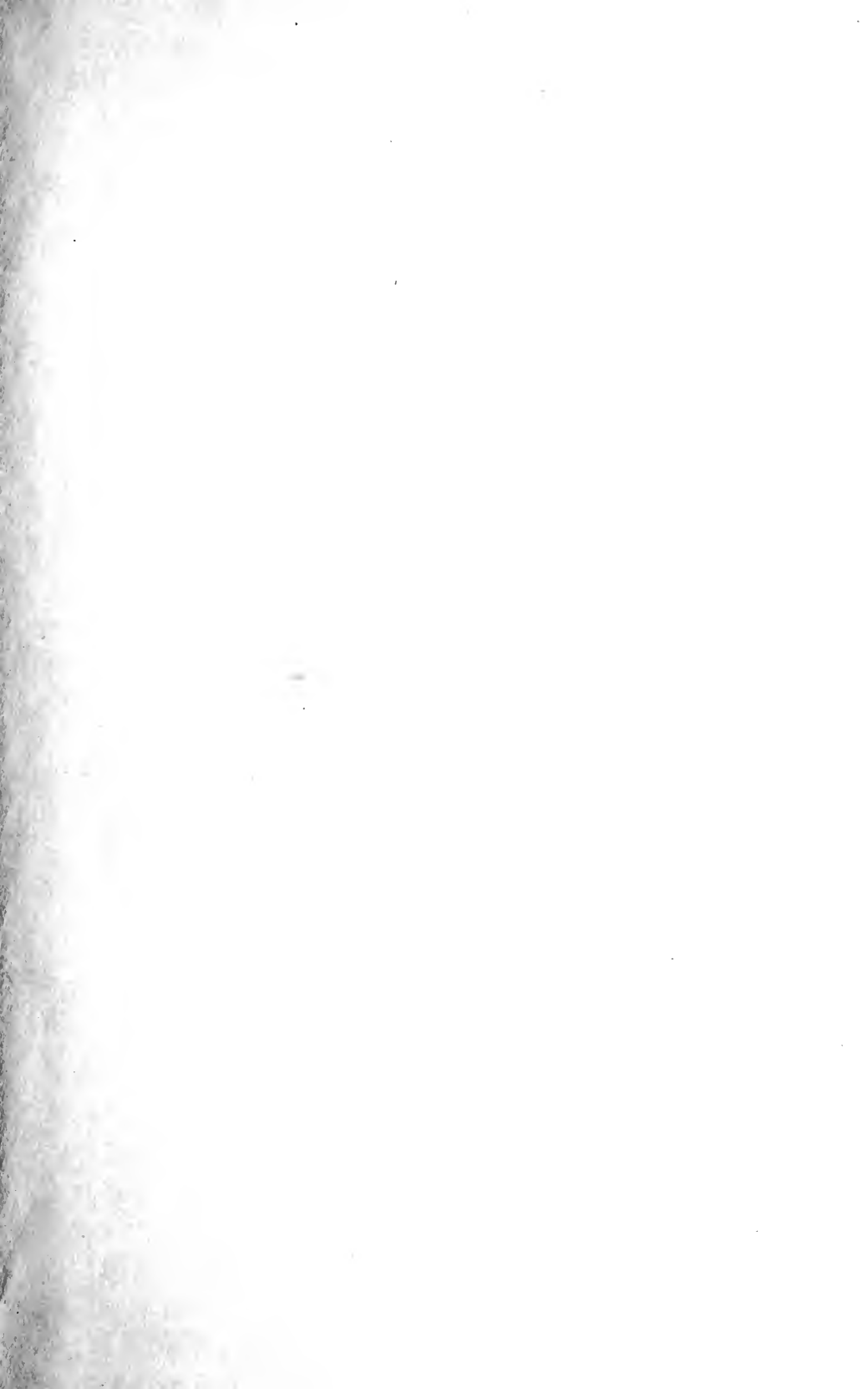
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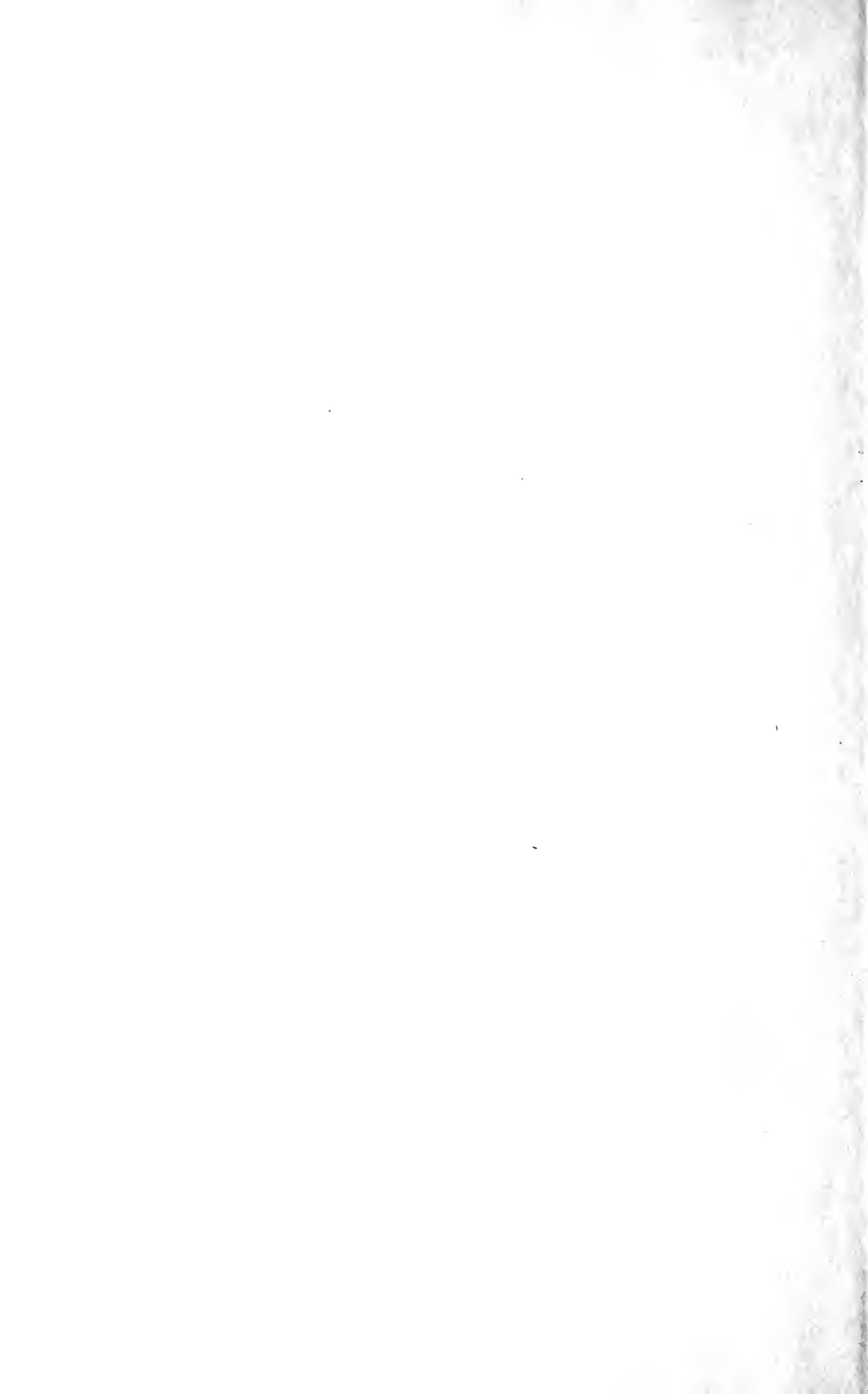
OF THE

GRAY HERBARIUM

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ARNOLD ARBORETUM
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ARNOLDIA



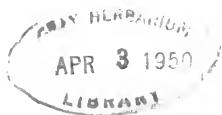
A continuation of the
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VOLUME X
1950

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**GRAY HERBARIUM
HARVARD UNIVERSITY**

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ARNOLDIA



A continuation of the
BULLETIN OF POPULAR INFORMATION
of the Arnold Arboretum, Harvard University

VOLUME 10

MARCH 31, 1950

NUMBER 1

FOREST-TREE BREEDING WORK OF THE CABOT FOUNDATION

FOREST-TREE breeding was first formally recognized at Harvard University with the establishment of the Maria Moors Cabot Foundation in 1937 by Dr. Godfrey L. Cabot of Boston. Since that time a number of basic studies have been started. These include investigations of natural variability in forest-tree species, hybridization of species of timber trees, vegetative propagation and the study of insect and disease resistance in forest trees. These projects involve work not only in genetics, but also in plant physiology, plant pathology, entomology, ecology, and wood anatomy. It is evident that considerable foresight was demonstrated by the founder in establishing the Cabot Foundation in an institution where workers in these special fields are available for collaborative study.

The tree breeding work of the Cabot Foundation was started at the Arnold Arboretum—an institution which may be truly called a tree breeder's paradise. Among the extensive collections are species of timber trees from all parts of the north temperate zone. It has been possible, for instance, to make hybrids between the Himalayan white pine and our native *Pinus strobus*, between *Populus Maximowiczii* from Manchuria and our native cottonwoods, and between other Old and New World species which have been established in the Arnold Arboretum for many years.

Earlier work in forest-tree breeding has shown that species hybrids are often possessed of remarkable growth vigor. One of the best examples is the London Plane tree, a hybrid of *Platanus occidentalis* from eastern United States and *P. orientalis* from southern Europe. This hybrid originated in England before 1700, and is now widely grown in Europe and North America where it will thrive under conditions too adverse for the parental species. Recent work with hybrid pines indicates that we can expect certain hybrids to grow nearly twice as fast as the parental species and similar growth acceleration has been reported in hybrid poplars and aspens. (Plate I)

The tree breeding program was started with pines and poplars. The pines, especially the white pines, are among our most valuable timber trees. Although poplars are not highly regarded by American foresters they grow rapidly and provide good wood for pulp and plastics.

The hybrid seedlings are grown at the Bussey Institution and propagated for field testing. Fortunately, the Case Estate at Weston became available at the time when extensive field tests of the hybrid poplars were needed. There are now more than 100 hybrid clones of poplars in the field test covering about three acres. In addition a collection of hybrids and parental species are maintained for a source of propagating wood. Test plots have also been planted near the Harvard Forest through the cooperation of the Metropolitan District Commission of Boston which has made available several plots of land in the Quabbin Reservoir District.

One of the most interesting aspects of the tree breeding program is the study of ecotypes of diverse geographic origin. Poplar clones native of the far north when grown at Weston start their growth early in the spring and stop growing early in the fall, while clones from more southern areas continue growth in the fall until killed by autumn frosts. These southern ecotypes make much greater growth than do their northern relatives, with differences in some cases of as much as 600 percent.

Crosses between northern and southern ecotypes of balsam poplar result in hybrids which grow as fast as the southern strain, but stop growing in the fall as early as does the northern strain. Such hybrids should be of great value for areas where cold hardiness is a critical factor. (Plate II) Similar work is being done with pines. With the cooperation of V. C. Dunlap of the United Fruit Company, pollen of Central American pines has been sent to the Arnold Arboretum by air mail and used to pollinate our hardy northern species. Even if such hybrids may not thrive in New England, they might be of great value in the southern states.

Hybrids between Asiatic and North American white pines were made in 1938 and these are now growing in the Arnold Arboretum. Several of these F_1 hybrids flowered in 1948 and 1949 and have been used in other cross combinations. The hybridization of pines was resumed on a larger scale when another tree breeder was added to the staff in 1948.

Some of the breeding work done at the Arnold Arboretum primarily for the production of ornamentals has proved to be of some interest in forestry and, conversely, it is to be expected that by-products of ornamental value will derive from the forest-tree breeding work. A cross between red and silver maple made in 1944 has shown unusually rapid growth. A few second generation segregates of this hybrid have already been obtained.

Tree breeding has been greatly facilitated by new techniques and modern transportation. One of the most important is the "greenhouse method" of crossing poplars, willows and elms. Dormant flowering branches are brought into the

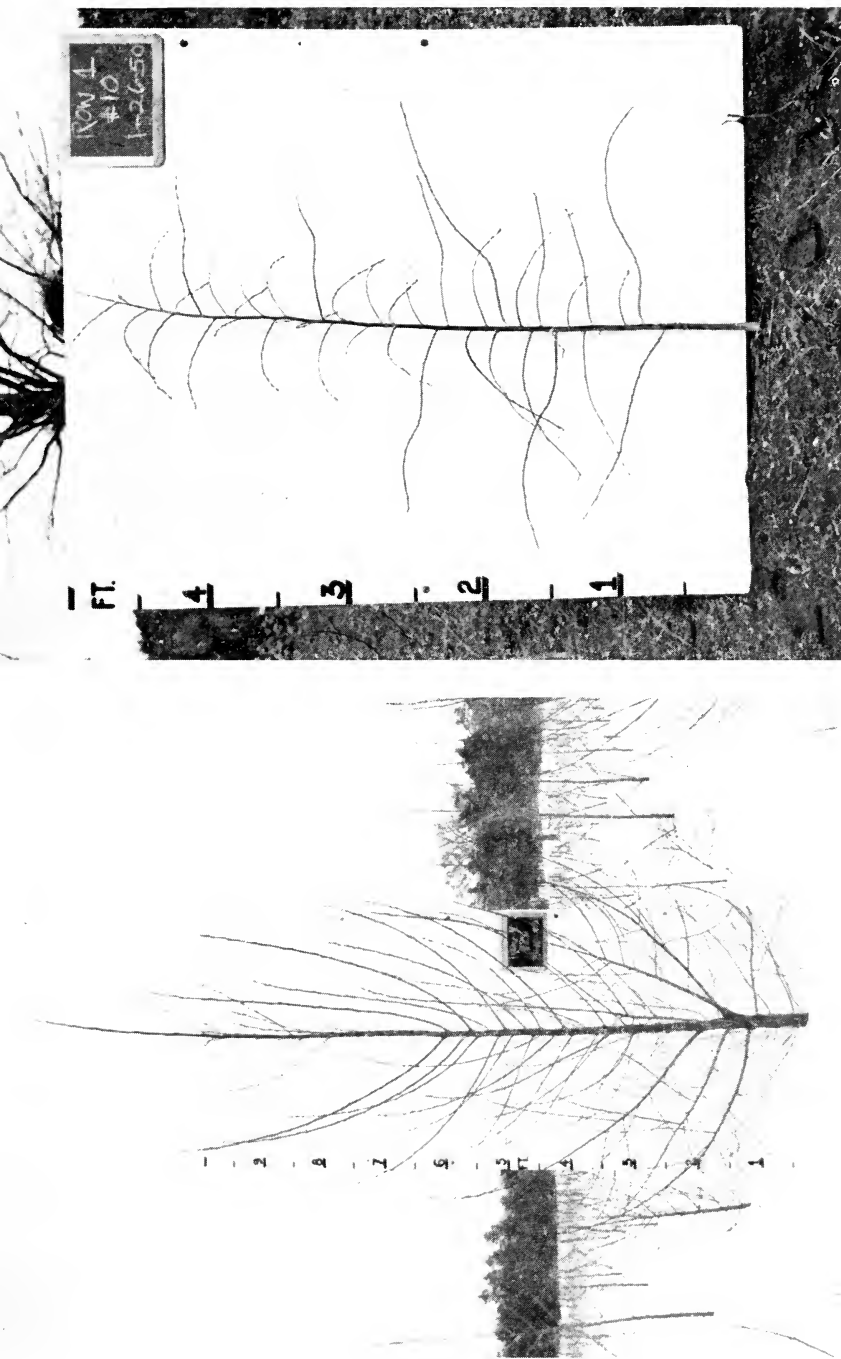


PLATE 1. *Left:* Hybrid poplar, over 13 feet in height, after two growing seasons from an unrooted cutting at the Arnold Arboretum's Case Estate, Weston, Massachusetts. *Right:* Hybrid aspen seedling after two growing seasons. This plant was transplanted at the end of the first season to a test plot near Petersham, Massachusetts. There has been less than a foot of height growth during the second season due to the shock of transplanting.

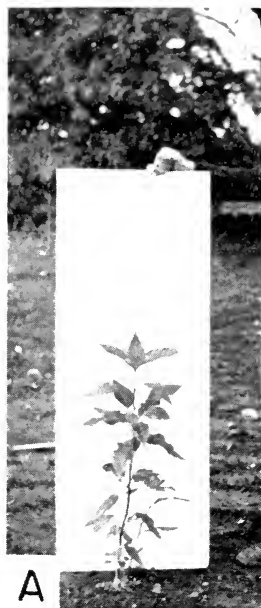


PLATE II. *Above:* Female Alaskan (A), male Montanan (M) balsam poplar and hybrid (F_1) between them photographed at the Cabot Foundation propagation area on the Case Estate, Weston, Massachusetts, September 10, 1949. The vigorous height growth of the hybrid compares favorably with the paternal parent (both of which represent a *single* season's growth from unrooted cuttings) but is in sharp contrast to the maternal parent which is *two* years old from an unrooted cutting. The young man in the picture is a student from Denmark. *Below:* Terminal portions of stems of the above, photographed on the same day, showing early cessation of growth in the female parent from Alaska and incorporation of this character in the hybrid. The male parent from Montana continued in active growth until the middle of October.

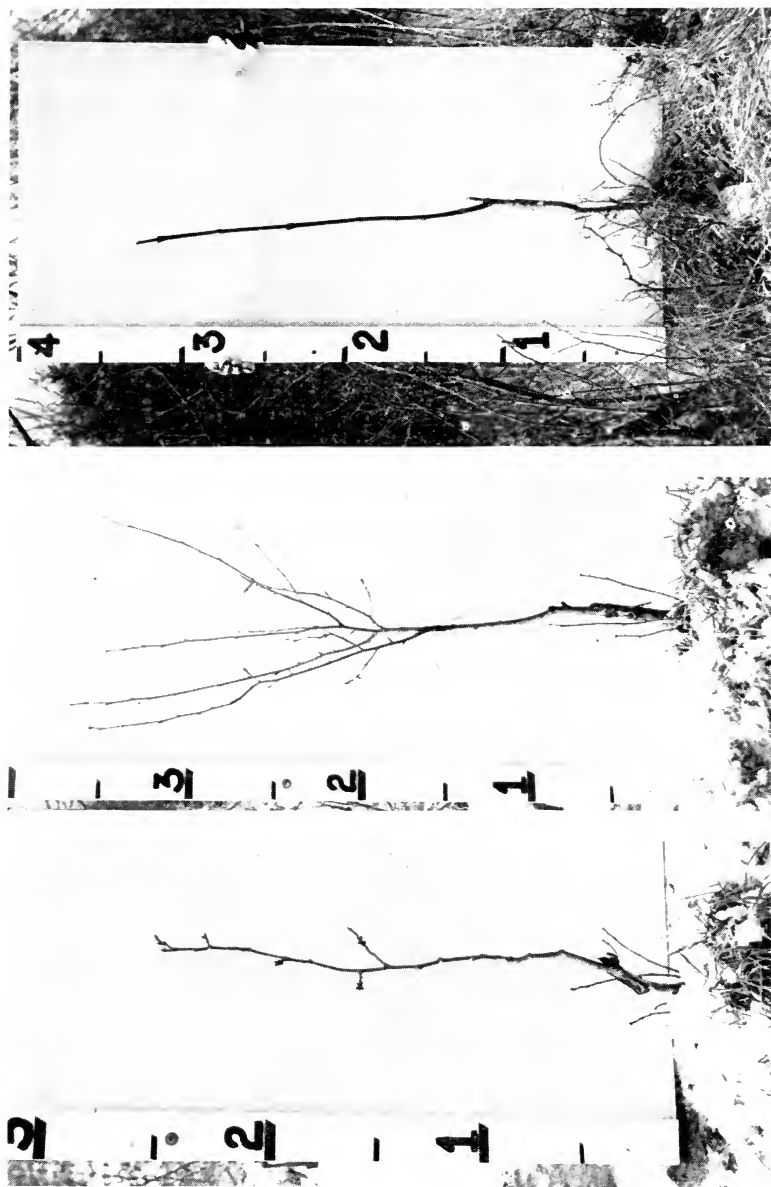


PLATE III. All photographs taken January, 1950. *Left:* Bottle-graft of large-tooth aspen on trembling aspen made in spring, 1949. Note numerous flower buds. *Middle:* Bottle-graft of paper birch on grey birch made in spring, 1948. These "dwarf trees" will be repotted this spring, moved into the greenhouse and forced into flower for crossing. In the fall they will be returned to the nursery bed. *Right:* Superior red ash on native wild white ash seedling in woodlot near the Harvard Forest; grafted spring, 1949.



PLATE IV. *Above:* Scaffold permitting access to crown of phenotypically élite Scotch pine, near Swedish Forest Tree Breeding Institute branch station, Brunsberg, Sweden. *Below:* Worker on scaffold platform as shown above inspecting recently pollinated cones. Photographs by the author while in Sweden en route to the Third World Forestry Congress held in Finland in the summer of 1949.

greenhouse and forced into flower. The crosses are made in the greenhouse and the seed will mature on the cut branches kept in a jar of water. Thus it is possible to ship cuttings of poplars from wide areas and make the crosses even when it may be impossible to grow one of the parental trees in this area. Pollen can also be shipped for long distances by air mail. During the current season we have sent pollen to cooperators in Sweden, Norway, Denmark and Holland. The ancient art of "bottle-grafting" has also been used with birches, where the fruiting branches do not live long enough as cut branches to mature their seed. By keeping such grafted plants pot bound it is possible to stimulate annual flowering. Such "dwarf trees" may thus be preserved and used for hybridization year after year. (Plate III)

Methods of vegetative propagation are of special interest to the tree breeder because hybrid vigor can be maintained only by such methods. The balsam poplars root easily from cuttings, but the aspens are usually difficult. The pines also root from cuttings with difficulty even when auxin treatment is used. A great deal of work on the rooting of cuttings has been done by Prof. Kenneth V. Thimann of Harvard, who has recently published a survey of the use of plant hormones in vegetative reproduction under the auspices of the Cabot Foundation. (Thimann, K. V. and Jane Behnke-Rogers. *The use of Auxins in the rooting of woody cuttings*. Maria Moors Cabot Foundation Pub. No. 1. 344 pp. 1950.)

The use of grafts as a means of introducing genetically superior individuals directly into the forest or woodlot is under investigation by the Cabot Foundation (Jour. For. 46: 524-525. 1948). This appears to be a feasible technique with such easily budded or grafted (but difficult to root) species as aspens, ashes and maples. (Plate III)

Rapid growth of forest trees is of little value if these vigorous hybrids or ecotypes are unduly subject to disease or insect injury. After all, death by disease or insect attack is just as final and disastrous in a stand of streamlined thoroughbreds as in a stand of mongrel relatives. Studies of disease resistance in hybrid trees has been started in cooperation with the U.S. Department of Agriculture, Bureau of Plant Industry. Our disease test plot of poplars is located in a relatively isolated area of the Arnold Arboretum. It is planned to extend these studies to include geographic races within various forest-tree species in a search for resistant or immune types for future breeding work.

Great progress has been made in the improvement of our domestic plants and animals by selection and hybridization. The utilization of hybrid vigor has made amazing progress in corn production and is being applied to other crops and to domestic animals. But foresters have only in recent years realized the potential possibilities in forest-tree breeding. In the United States the reluctance of foresters to adopt genetic methods is understandable since most of them are confronted at present with the problem of managing large areas of forests with budgets so limited that the care of the forests must be restricted to routine silvicultural treat-

ment. European foresters, although still properly concerned with problems of cultural practice, are increasingly aware of the need for forest genetics. In Sweden alone about twice as much money is expended for forest-tree improvement as is spent for such purposes by all of the government, college and private agencies in the entire United States.

With the increasing need for substituting wood and wood products for our non-renewable resources of gas, coal and metals, a more intensive management of our forests appears to be imminent. Under such conditions a logical approach to more efficient wood production will most certainly involve genetic analyses of wild forest stock, based on progeny tests, and the inauguration of carefully planned tree breeding programs to fulfill specific local needs.

SCOTT S. PAULEY

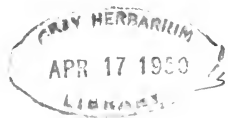
Harvard Forest, Petersham

Note

Regular Field Class again this year

A Field Class for the study of the flowering trees and shrubs as they are growing in the Arnold Arboretum, will again be held this year. The first meeting will be on Saturday, April 29, at 10:00 A.M., meeting at the Forest Hills Gate. Weekly meetings will be held every Saturday morning during May, unless prevented by inclement weather, when the class will meet the next clear weekday morning. The period is two hours long, and discussions will be held about the plants as they come into bloom during this spring season. Members of the "Friends of the Arnold Arboretum" are welcome to attend all classes without charge. Others must register in advance by mail and pay a registration fee.

ARNOLDIA



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VOLUME 10

APRIL 14, 1950

NUMBER 2

THE FORSYTHIAS*

THE forsythias are among the most popular of garden shrubs, used chiefly in those regions of the country where their early spring flowers lend conspicuous color to gardens which have been apparently lifeless and dreary throughout the entire winter. Most of them are natives of the Orient, although a few have recently been developed in this country. The oriental species first came to this country about a hundred years ago, and since that time have proved as popular as almost any other woody plant for garden use, because their conspicuous color, and the ease with which they can be grown, make them adaptable to many soils and many situations.

In the North, the bright yellow, scentless flowers appear before the leaves, usually in March and April, depending on locations, although in the Arnold Arboretum in 1944, due to an unusually late spring, *Forsythia intermedia* varieties were in full bloom during mid-May when lilacs were also at their best. One of their interesting (and useful) qualities is the ability to grow in city gardens, where atmospheric conditions, and frequently moisture conditions, are not to the liking of many other plants. They are practically free from insect and disease pests. Some are valued for their arching or trailing habit and only one (*F. viridissima*) is graced with conspicuous autumn color—a purplish red. Since this is one of the parents of *F. intermedia*, this quality of autumn color sometimes crops up to some extent in some of the clones in this hybrid species. The leaves of all forsythias are opposite, and in most species are sufficiently distinct so that they can be distinguished one from the other, by the amateur when they are not in flower. The fruits are merely dry capsules with no ornamental value.

One of the most disturbing things about these plants, to those of us who appreciate plants growing in their normal habit, is the way that these are sometimes mutilated by improper pruning. Because they withstand city conditions

* Reprinted from THE NATIONAL HORTICULTURAL MAGAZINE, April 1949.

and are easy to grow, they are frequently used in public plantings, where uninformed maintenance men merely cut off the stems at an even five feet or so from the ground. This may be classified under the heading of so-called "formal" pruning, but forsythias are not the plants for this treatment. They should be used only where sufficient space is available for them to grow and expand naturally. Sometimes in planting a bank, it is advisable to plant the trailing types closely together in order to obtain proper ground coverage, but normally they should have plenty of room. A single plant needs at least 8 to 10' in order to grow properly. Too often we see forsythia planted a mere 3' from a walk and then mercilessly hacked for the rest of its life in order to properly "restrain" it.

In 1844, Robert Fortune brought the first forsythias to Europe from the Orient. The manner in which this was done he has described in a most interesting way, for in those days, the trip to England from the Orient was a long and tedious one. The old sailing ships had to go around "The Horn" and in doing so the trip took four to five months. It was most difficult to keep seeds in a viable condition without modern refrigeration methods, and plants were a serious problem indeed. They had to be protected from salt water spray, they had to have fresh water, which of course was at a premium, and they had to have sunlight.

Wardian cases were used by the early plant explorer to overcome these difficulties. (They are now commonly called solariums.) Sheets of glass were sealed together with sufficient soil in the bottom that rooted cuttings or very small plants could be grown in them. Prior to the sailing of the ship they were watered and sealed, and serviced occasionally when the ship touched port. According to Fortune, "large vessels with poops" were preferred for the trip from the Orient, for on such vessels the cases could usually be carried out of range of the salt spray.

The pruning of forsythias is not difficult, but their general appearance is dependent on proper pruning at the proper time. Since all forsythias have flower buds formed the previous year, they should be pruned after they bloom, since pruning in the early spring before they flower merely reduces the number of flowers produced that year. As far as the vigor of the plants themselves is concerned, the pruning can be done either before or after the blooming period. The arching branches, and in some cases, the trailing branches, are essential to good form, and so, any pruning is usually a thinning out of the older and overgrown branches, rather than a "heading back" of all branches on the entire plant. *Forsythia suspensa sieboldi* is trailing in habit, while the clones of *F. intermedia* are upright. *Forsythia viridissima* and *ovata* are intermediate between the two, while there are several clones that are actually dwarf, and should receive little or no pruning.

On occasion, it may be necessary to prune forsythias heavily—even cut them to within six inches of the ground. This can be done and they will recover quickly. We had a bank planting of forsythias in the Arnold Arboretum a few years ago

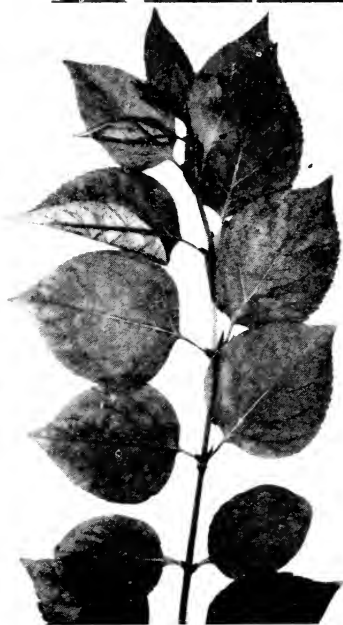


PLATE V

Forsythia viridissima; *F. suspensa sieboldi*;
F. europaea; *F. ovata*

that had become too tall and overgrown so that with heavy snow the breakage was very heavy. The cheapest (and easiest) way to bring the planting back into good appearance, was to cut all plants right to the ground. This was done in the very early spring, and within two short years the entire planting was again blooming beautifully. Lilacs, privets and many other shrubs can be treated this vigorously—on occasion—and be expected to recover. The first year after such heavy pruning the plants are not much to look at, hence in the small garden, whenever possible, it would seem best to prune by thinning only, leaving most of the younger and better branches to continue bearing flowers. A heavy pruning should not be done in the summer, or too late in the spring, for, if a prolonged dry spell follows, the plants may become too weakened to go through the first winter successfully. A renewal pruning each year or two, is certainly the best way (and the least conspicuous way) of keeping individual plants in good condition.

As a group the forsythias are hardy in the northern United States, but the flower buds of the species are frequently killed in severe winters, cause enough why such plants are not used where winter temperatures normally go considerably below zero. The species with the flower buds that have proved to be the most hardy is *F. ovata*. It is decidedly inferior to most of the others in flower, size and color, blooms about ten days before most, but where a forsythia is wanted in areas where most suffer winter injury, this might be tried. If this does not bloom properly (because of winter killed flower buds) certainly no other forsythia will succeed.

The habit of the forsythia is one of the two principal reasons why it is grown. All species and varieties are dense, well covered with foliage. The lowest is probably "Arnold Dwarf," a recent hybrid grown at the Arnold Arboretum. The original plant was only about 2' tall after six years of growth, yet it had increased to 7' in diameter, for it roots readily from the tips of its branches. It makes an excellent ground cover but seven-year-old plants have yet to produce their first flowers. Another dwarf type, originating at the New York Botanical Gardens, has been named *F. viridissima brouxensis*, and it does flower. Still another, and in the trade for several years and termed *F. suspensa* "*fortunei nana*," is a dense dwarf but in six years at the Arnold Arboretum has failed to bloom.

The chief trailing forsythia is *F. suspensa sieboldi*, often with long branches prostrate on the ground. Planted at the top of a bank or at the edge of a wall, trailing shoots 6' long overhang gracefully.

Forsythia ovata is rounded in habit, growing about 6' tall. Most of the remainder of the forsythias are dense shrubs, eventually growing about 9' tall and often having gracefully arching branches. When properly pruned and grown with plenty of room, these plants have a pleasingly graceful habit that lends beauty to them even when they are not in flower.

The chief value of forsythias is of course their flowers. Twenty-four species and varieties have been grown in the Arnold Arboretum over a period of years, but

even with the most careful scrutiny they can be divided into only five color groups (and possibly this is stretching it a bit!) The darkest is of course *F. intermedia spectabilis*, which has no peer in respect to deep yellow color. At least five are very light yellow (Empire yellow according to the Royal Horticultural Society's Colour Chart). Of these four could be recommended, *F. ovata*—chiefly for its hardiness and where this is not a factor, it might be discarded; *F. intermedia* vars. *densiflora* and *primulina* and *F. suspensa pallida*. The last named variety is recommended

FORSYTHIAS

Results of Color Comparisons of Forsythia Flowers

1945-1947

	Width of petal	Diameter of flowers	Color Chart number	Color Chart name
europaea	.7	4.1	3/1	aureolin
giraldiana	.5	3.0	603	empire yellow
intermedia	.7	3.2	4/1	lemon yellow
* “ densiflora	.6	3.8	603	empire yellow
* “ primulina	.8	4.4	603	empire yellow
* “ spectabilis	.9	4.5	4	lemon yellow
“ vitellina	.6	3.6	3	aureolin
japonica saxatilis	.5	3.2	3/1	aureolin
*ovata	.5	2.6	603	empire yellow
ovata × europaea	.6	3.5	3	aureolin
suspensa				
“ atrocaulis	.5	3.4	3/1	aureolin
“ decipiens	.8	4.0	4/1	lemon yellow
* “ fortunei	.8	3.9	3	aureolin
* “ pallida	.9	4.0	603	empire yellow
“ pubescens				
* “ sieboldi	.9	3.0	3	aureolin
“ variegata				
viridissima				
* “ bronxensis				
* “ koreana	.5	2.9	4/1	lemon yellow
*“Arnold Dwarf”				
“Arnold Giant”	1.1	4.8	4	lemon yellow
*“Spring Glory”			3/1	aureolin
Arnold Arboretum—				
Sdlg. No. 22716	1.1	4.0	3/1	aureolin

*recommended for one purpose or another

(1-27-49)



PLATE VI. *Forsythia viridissima bronvensis*

chiefly for its gracefully arching habit. *Forsythia intermedia spectabilis* and *F. intermedia densiflora* produce more flowers than any other variety. The other forsythias are distributed between these color extremes as is shown in the table. A few years ago a "new" variety appeared in the trade catalogues—*F. suspensa* "*fortunei aurea*." After several years' trial at the Arnold Arboretum, the plant which we obtained in all good faith under this name appeared to be identical with *F. suspensa fortunei*.

All characteristics considered, eleven forsythias might be valuable enough for one reason or another to warrant growing in our gardens. Thirteen might be overlooked entirely. It is always difficult (and dangerous!) to make such eliminations, but that is just what I propose here, for reasons already mentioned and apparent if one pursues the comparisons in the table on page 13.

The records noted in the table are suggestive only. It should be obvious to anyone familiar with plants that flower sizes vary on the same plant and even on the same branch. Also the flower color varies similarly, aging flowers being lighter colored, younger flowers being more deeply colored. These records were taken two different years and a conscious effort was made to take specimens of comparable parts of the plants. Sometimes a forsythia with small flowers and very wide petals will make a better display than a plant which has larger flowers but very narrow petals. The table is offered merely as a basis on which comparisons can be based. For those who will not agree with such records, I would like to point out the fact that these 24 species and varieties are similar in many respects, and some method should be found by which a number of them can be eliminated from our nursery catalogues. Their continued listing often fills us with renewed anticipation each time we order a plant with a "different name" only to wind up

severely disappointed when we learn, after several years of growing, that the "new name" plant gives a landscape effect which is identical with a type that has been in this country a century.

The following key may be of assistance to some who wish to tell the species apart when flowers have passed, but leaves are fully developed:—

Leaf Key to Forsythias

1. Leaves often deeply lobed or divided into three parts, twigs hollow but solid where leaves are attached. *F. suspensa*
1. Leaves not divided into three parts.
 2. Leaves entire. *F. europaea*
 2. Leaves mostly with teeth, only a few entire.
 3. Leaves broad ovate, mature branches yellowish. *F. ovata*
 3. Leaves narrow and mature branches greenish or brownish.
 4. Pith usually solid where leaves occur, leaves sometimes divided into three parts, especially on vigorous shoots. *F. intermedia*
 4. Pith usually in partitions. *F. viridissima*

Notes Concerning the Species and Their Varieties

europaea: Flowers usually borne singly, hence not as conspicuous in flower as some of the others. The flowers and flower buds are almost as hardy as those of *F. ovata*.

giraldiana: No better than *F. intermedia* varieties.

intermedia: A cross of *viridissima* and *suspensa*, hence it has some characteristics of both parents—occasionally some autumn color but not pronounced and the habit of *F. suspensa fortunei* with upright arching branches. The varieties *densiflora* and *spectabilis* have the most flowers of any of the forsythias, with *spectabilis* having the largest and darkest yellow flowers. The variety *primulina* is valued for its light colored flowers and *vitellina* is more or less of botanical interest only.

japonica: Both the species and its Korean variety *saxatilis*, bear flowers singly, hence these do not make ornamental plants comparable with the better species listed here.

ovata: Although this, too, bears only solitary flowers, the plant is valued for its flower buds which are harder than those of the other forsythia species. It blooms about ten days in advance of most types.

ovata × *europaea*: A cross made at the Arnold Arboretum before 1935, but resulting in plants that were not superior ornamentally in any way to the parents.

suspensa: If we are to take Alfred Rehder's listing literally, there is no such thing as *F. suspensa* since the variety *sieboldi* is taken to be "the type of the species." The variety *sieboldi* has long drooping or prostrate stems, is excellent for bank planting or for overhanging walls and has even been used as a wall plant and trained on a trellis; *pallida* has the lightest flowers of the *suspensa* varieties and both *pallida* and *fortunei* are vigorous upright shrubs yet with excellent arching and spreading branches that give a graceful appearance. The variety *decipiens* is not as good an ornamental because the flowers are solitary and not frequently in threes as is the case with the other varieties, and the twigs of *atrocaulis* and *pubescens* are not sufficiently colorful to warrant their being grown in place of the others. The form with variegated foliage I have never seen, but plants with variegated foliage are none too ornamental in most situations.

viridissima: This species is the least hardy of the group, not hardy at the Arnold Arboretum, but its Korean variety *koreana* is, and is just as ornamental. Both have a rich purplish red autumn color, making them valuable in the fall. Comparatively recently the variety *bronxensis* was named at the New York Botanical Garden, having grown there for nearly ten years. This low dwarf does flower and has merit for this reason.

Horticultural varieties: "Arnold Dwarf" is a cross between *F. intermedia* and *F. japonica saxatilis* and developed by the Arnold Arboretum in 1942. It may prove of value as a ground cover for it roots readily, six-year-old plants are not over 2' tall, but are 7' across. The drooping branches strike root readily and form a mat of foliage. However, it has not yet flowered.

"Arnold Giant" is a tetraploid forsythia originated at the Arnold Arboretum. Although the flowers are large and very dark yellow, it proved difficult to propagate from cuttings. Because of this difficulty, and due to the fact that some of the triploids obtained by crossing the tetraploid with diploid forms seemed to be superior in many respects, the "Arnold Giant" is not recommended for further distribution.

"Spring Glory" originated about 1935 as a bud sport of *F. intermedia primulina* in the experimental garden of the late M. H. Horvath of Cleveland, Ohio. He claimed that this sport was distinct from the variety because it produced a larger flower and 30 to 50% more blossoms. It has been propagated and widely advertised for these qualities.

The last mentioned in the table, Arnold Arboretum Seedling No. 22716, is merely mentioned for its very wide flower petal. This seedling was discontinued when "Arnold Giant" appeared, but may have interest after all since it can be propagated as easily as other forsythias.

DONALD WYMAN

ARNOLDIA



A continuation of the BULLETIN OF POPULAR INFORMATION of the Arnold Arboretum, Harvard University

VOLUME 10

APRIL 28, 1950

NUMBER 3

THE BETTER ORIENTAL CHERRIES

THERE is always much interest in the oriental flowering cherries at this time throughout the eastern United States. In Washington, Philadelphia, New York and other eastern cities extensive plantings of them can be seen in late April when they first burst into bloom, for the flowers have the most desirable trait of appearing before the leaves (in the case of most single flowered forms) or with the leaves in the case of the double flowered forms. Certainly in no cases are the flowers hidden by the foliage! In New England there are some that are perfectly hardy, some that are hardy in all but the most severe winters, and others which should not be grown at all, either because they are tender, or because they are similar in flower to some of the better species and varieties.

The Arnold Arboretum has been responsible for the introduction of many of these oriental trees and has planted numerous varieties over the years. Charles Sprague Sargent, Ernest Henry Wilson and others have been outstanding in the study and introduction of many of these plants, so it may prove helpful to gardeners in New England to review some information about these plants at this time, as they come into flower.

The Sargent Cherry is the tallest of all, being a standard tree up to 75 feet in height, although in this country few trees have exceeded 50 feet. The others are considerably smaller, and the double flowered *Prunus serrulata* varieties seldom grow over 20 feet in height. The single flowered forms have small fruits, usually bluish black, and the double flowered forms produce few if any fruits. Even though the fruits are produced, they appear after the leaves are fully developed and so are completely hidden. Thus these trees have practically no ornamental value when in fruit—an important point. One or two, like the Sargent Cherry have brilliant autumn color, but most have no autumn color at all. The bark of the Sargent Cherry is interesting in the winter and that of *Prunus serrula* is really outstanding because of its glossy red appearance, but the winter effect of most of the rest is negligible.

Consequently, with a very few exceptions, these trees are of ornamental interest only during the period they are in flower, another important point to bear in mind especially when planting the small home grounds where space is often at a premium. The length of period these plants are in flower depends on the weather. If the weather is cool at the time the flowers open, the trees with single flowers may be colorful for a week. On the other hand, if the weather is hot, or if there are heavy rains at the time of full bloom, these cherries may be of interest for only two or three days.

The double flowered varieties will of course be colorful for a much longer period, simply because there are many more petals. Two weeks is probably the maximum time they will be of interest, providing the weather is favorable, but again, if hot weather intervenes, this period will be reduced considerably. One new hybrid of *Prunus subhirtella* should be mentioned in this respect, for it has the desirable trait of opening its flowers consecutively over at least a two week period. This hybrid was produced at the Arnold Arboretum in 1941 and has been named *Prunus* "Hally Jolivette" (*Arnoldia*: 8: 9-12, Dec. 1948).

Consequently, with no ornamental fruits, with little autumn color, these plants as a group can be enjoyed only for the limited time they are in flower. When compared, as a group, with the flowering crab apples for instance, one might think twice before using valuable space to plant them when other trees like the crab apples might be selected which always have two seasons of interest, and sometimes more.

Propagation

There has been considerable discussion during the past thirty years concerning methods of propagation for these interesting trees. The species like *P. sargentii*, *P. yedoensis*, *P. incisa*, etc. will breed true from seed unless the seed is collected from trees growing in close proximity to other closely related cherries. The varieties, especially those of *P. serrulata*, must be budded or grafted on some understock, since cuttings root with difficulty. It is the understock which has caused much discussion. At one time *P. sargentii* was enthusiastically recommended, but long experience both with our own trees in the Arnold Arboretum and with trees in the extensive collection in Durand Eastman Park in Rochester, N.Y., has shown that *P. avium*, the Mazzard Cherry, is better and more permanent as an understock. Varieties of *P. yedoensis* can be grafted on seedlings of the species, and varieties of *P. subhirtella* can be grafted on seedlings of that species, but for the majority of the varieties of the oriental cherries, Mazzard Cherry understock has proved most reliable from a long-term view point.

Pests and Culture

There are few insect and disease troubles to bother these cherries. Scale insects are perhaps the most prominent, which means that the trees should be sprayed with a dormant oil every two or three years, unless the pest is serious,

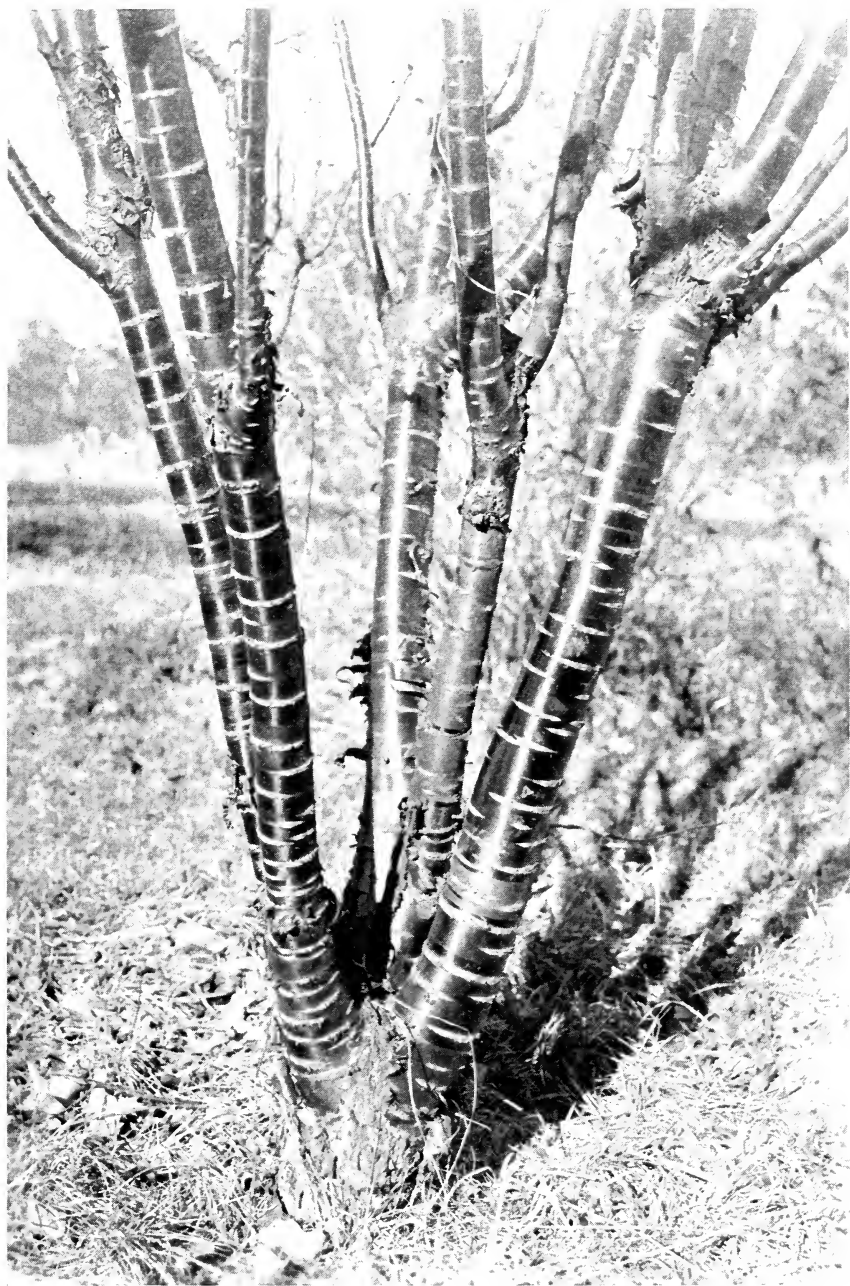


PLATE VII

The bark of *Prunus serrula* is a rich reddish brown throughout the year.

when they should be sprayed annually. In the collections at the Arnold Arboretum, canker worm is about the only other pest with which we have to deal, easily controlled with a spray of DDT or lead arsenate applied at the time the small worms first begin to feed. Consequently, it must be admitted that as far as pests are concerned, the oriental cherries are no worse off than the crab apples.

It is perhaps unfortunate that so many people have the impression that these trees are best planted beside water. It is true that in such situations they are very beautiful, and the reflections formed as the trees blossom are superb, but trees planted this way can have a very short life span. Such situations frequently have very poor drainage, so that a tree may grow satisfactorily for a few years then die suddenly, merely because the drainage was not satisfactory. Good soil and good drainage are both aids in producing trees that have a maximum life span, and in the case of all but one or two species (such as the Sargent Cherry) this life span may be under twenty years. They are not long lived trees, for their branching habit is conducive to weak crotches, and their thin bark is often susceptible to "sun scald" in the more severe winters.

Varieties

Over 150 species and varieties of oriental cherry trees have been named by Japanese horticulturists and at least fifty are at present growing in the United States. The amateur gardener can have a difficult time determining which are best. Hardiness is the first consideration. The Sargent Cherry is the hardiest of the species and "Kwanzan" and "Fugenzo" are the hardiest of the double flowered varieties, at least in New England.

The close similarity of some of the double flowered varieties is marked. All but the specialist want trees that are distinct from a landscape point of view. Some of the varieties have flower clusters with only slightly longer flower stalks, or the flowers are just a shade lighter or darker than some of the others, or the leaf serrations or pubescence varies from some of the others. Such botanical characteristics are not conducive to distinct ornamental variations when the trees are judged in a landscape setting. Then too, the flowers of some varieties are considerably more fragrant than those of some others, reason enough why the fragrant flowering forms should be first selected. Because of these things, the better varieties only are here recommended and briefly discussed. Other varieties may be grown by the specialist who has the space, the funds and the time to grow plants with only minor variations.

The oriental cherries recommended below, are divided into general groups according to habit or flowers, in order to make it easier to select certain ones for specific landscape purposes.

1. Bush-like Trees.

Prunus "Hally Jolivette" a hybrid of *P. subhirtella* developed at the Arnold Arboretum will probably develop into a small bushy tree. The flowers are small,

white, semi-double, and do not open all at once but consecutively over a two week period, reason enough why it should be recommended here.

Prunus incisa, the Fuji Cherry, is a delightful bushy tree, about 18 feet tall and very dense. Native in Japan, it has long been a favorite in this country and in England as well because of the extreme floriferous condition when in bloom. Its small white flowers, sometimes pinkish, are produced regularly each year in such great profusion that sometimes it is difficult to see the branches and twigs. It was first introduced into America in 1910.

Prunus nipponica, the Nipponese Cherry, is similar in size and density of branches and foliage. It also has white to pinkish flowers and is a native of Japan. Perhaps it might be desired in preference to some of the other cherries because it is one of the few cherries the foliage of which turns a splendid yellow to orange-crimson in the fall.

2. Standard trees, 30 feet or more in height.

Prunus maximowiczii, the Miyama cherry, has white, single flowers. It eventually reaches a height of 30 feet, is a native of Korea and was first introduced into America in 1892. Although beautiful in flower, it is particularly noted for the fact that its foliage turns scarlet in the autumn. This desirable trait, brings it into the small group of cherries with two seasons of ornamental interest, and so makes it more desirable from a landscape viewpoint than some of the others. Unfortunately it is very difficult to locate available plants from commercial nurseries.

Prunus sargentii, the Sargent Cherry, was named after Charles Sprague Sargent, first Director of the Arnold Arboretum, and has been recommended many times in former issues of *Arnoldia*. It is a standard tree of 75 feet in height in its native land, but probably will not grow over 40-50 feet in America. The flowers are single, large and deep pink and the young leaves, appearing as the flowers fade, are a rich bronze color as they unfurl, an added asset. In habit it is wide and spreading with a rounded top, but a fastigiate form is growing in the Arnold Arboretum and will be available from certain nurseries within a few years. It is one of the hardiest and the tallest of all the oriental cherries and is blessed with a rich red autumn color, giving it outstanding ornamental value in the fall as well as in the spring. This tree can be recommended for street tree use as well as use as a specimen, in most of New England.

Prunus serrula is a tree as yet unavailable outside arboretums in this country. It grows about 30 feet tall, has white flowers, but is especially noted for its brilliant glossy, reddish-brown bark, a striking ornamental character that lends beauty and interest to this tree throughout the entire year.

Prunus subhirtella, the Higan Cherry, is perhaps best known for its varieties. The flowers are single, light pink to almost white, and the foliage is of a very fine texture. The variety *autumnalis*, has semi-double flowers $\frac{3}{4}$ of an inch in di-

ameter, that appear (some years) in the fall as well as the spring, although very few are produced in the fall. The Higan Cherry is one of the earliest cherries to bloom, is very graceful and floriferous. The variety "Moni-jigari" has double deep pink flowers and is most beautiful.

Prunus yedoensis, the Yoshino Cherry, is the one so widely planted around the Tidal Basin at Washington. Nearly 900 trees were presented to the city of Washington by the Mayor of Tokyo as a gift of friendship in 1912. These trees have prospered and have been appreciated by millions of visitors. The Yoshino Cherry has single white to pink flowers, about one inch in diameter that are slightly fragrant. It was first introduced into America by the Arnold Arboretum in 1902, and like all other cherries, is shown off to best advantage if planted in with an evergreen background.

3. Small Trees with pendulous branches.

Prunus subhirtella pendula, the popular Weeping Cherry, is probably the oldest oriental cherry tree in this country, having first appeared here about 1842. Its long pendulous branches and pink flowers are familiar to most gardeners. A double flowered form of this variety is growing in this country and is very beautiful indeed. The form of *Prunus yedoensis perpendens* that is growing in the Arnold Arboretum is not as graceful as is the more common Weeping Cherry.

4. Small trees with fastigate form.

Prunus serrulata "Amanogawa," is the only true fastigate oriental cherry worth growing. Its habit is favorably compared with that of the Lombardy Poplar, although of course it is a much smaller tree, seldom growing over 20 feet tall. The flowers are semi-double, light pink, fragrant, $1\frac{3}{4}$ inches across. David Fairchild is credited with first introducing this interesting variety from Japan in 1906. A very high percentage of the seedlings will retain the fastigate form of the parent.

5. Small trees with spreading or upright branches.

A. Flowers single or slightly semi-double (all are varieties of *P. serrulata*).

"Botan-zakura" with semi-double flowers, pink, 2 inches in diameter, 6-15 petals and fragrant.

"Gyoiko" the Japanese name meaning "Imperial yellowish costume" because the flowers are actually a yellowish green. This color is rather pleasing, the flowers being semi-double and $1\frac{1}{2}$ inches in diameter. The variety "Ukon" is similar but the flowers are larger.

"Jo-nioi" is the most fragrant of all the varieties of *P. serrulata*, according to E. H. Wilson, reason enough why it should be grown. The flowers are mostly single, white and $1\frac{1}{2}$ inches in diameter.

"Taki-nioi" the Japanese name meaning "fragrant cascade." This tree sel-



PLATE VIII

“Shogetsu” is one of the better double flowered oriental cherries, and bears a profuse crop of blossoms annually.

dom grows over 12 feet tall. The flowers are single, white, $1\frac{1}{4}$ inches in diameter and fragrant.

“Washino-o” with single white flowers, $1\frac{1}{2}$ inches in diameter and very fragrant.

B. Flowers double (varieties of *P. serrulata* except *P. sieboldi*).

Prunus sieboldi, the Naden Cherry, is the first of the double flowered oriental cherries to bloom. The flowers are light pink, about $1\frac{1}{2}$ inches across and fragrant.

“Fugenzo” which is also found in nurseries under the name of “James H. Veitch” or “Kofugen” is a popular variety for the flowers are as much as $2\frac{1}{2}$ inches in diameter. They are a rosy pink at first, fading to a light pink. Paul Russell, in his excellent work “The Oriental Flowering Cherries” remarks that this variety was known and cultivated by the Japanese 500 years ago.

“Kwanzan” is probably the most popular of all the double flowered varieties, and justly so. It is one of the most hardy. The flowers are a deep pink and as much as $2\frac{1}{2}$ inches in diameter, with 30 or more petals. The young foliage is a bright copper color as it first appears, adding materially to the colorful display of this tree in flower.

“Shirotae” is the best of the double white flowering cherries. Its Japanese name means “snow white.” It is unfortunate that there is no double white form with as many petals as “Kwanzan” (30 or more) and this variety only has 12. However, the petals are slightly ruffled at the edges and this gives a most pleasing effect. The flowers are $1\frac{1}{2}$ –2 inches in diameter and fragrant.

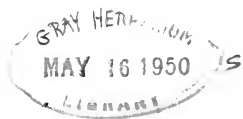
“Shogetsu” considered by some to be the most handsome of the double flowered cherries. It grows about 15 feet tall, is broad and flat topped. The flowers have about 30 petals, are a very pale pink color, often with a white center, and are up to 2 inches across.

DONALD WYMAN

Field Class

Registrations are still open for the Saturday morning Field Class at the Arnold Arboretum which meets Saturday, 10 to 12 o'clock, from April 29 to May 27.

ARNOLDIA



A continuation of the BULLETIN OF POPULAR INFORMATION of the Arnold Arboretum, Harvard University

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THE BEST OF THE CRAB APPLES

THE Oriental Crab Apples are fast becoming the most popular group of flowering trees in America. They can be grown over a very wide area, actually in about 75% of the gardens in this country. There are nearly 250 species and varieties being grown commercially—a most confusing number from which the average home owner is expected to select. One of the reasons for this discussion is to emphasize this very important fact, and to start you thinking in terms of selecting “the best.” No list that any one individual will offer as “the best” will be unanimously accepted, but the time and effort needed to make this study will have been worth the effort, if it initiates thinking in the right direction,—that of concentrating on some species and varieties that are superior to others, and eliminating inferior types.

There are several large collections of named varieties being grown in America today. Mr. A. F. den Boer of the Des Moines Water Works has perhaps the most complete, of over 200. The Arnold Arboretum has nearly that number of named varieties and several thousand seedling hybrids coming along for later selection. The Morton Arboretum, Rochester Park system and the Arthur Hoyt Scott Horticultural Foundation at Swarthmore all have collections. Information obtained in these collections over a period of years was pooled a few years ago and a publication entitled “Crab Apples for America” was offered in which all information pertaining to known living varieties was given. Since 1943, a few changes have been made in some of our selections. Using this material as a basis for the study and including information since gleaned from the large collection growing at the Arnold Arboretum, the following notations on this very valuable group of plants are offered.

The difference between so-called ornamental crab apples and true apples, is slim. Anything over two inches in diameter is considered an apple as far as this study is concerned. All crab apples are valued for their flowers and many for

their fruits as well. Some have interesting form, some hold their fruits all winter. It is these several items which make the crab apples so much more effective from the landscape point of view than the oriental cherries, the fruits of which are either non-existent or else are inconspicuous. Some of the more recently introduced varieties have foliage of an interesting reddish color, which adds materially to their usefulness in the planting plan. Still others, with excellent ornamental qualities, have fruits which make excellent jellies as well, being a very important reason for growing them under certain conditions and in certain areas.

Most of these species hybridize freely, and when grown from seed, especially from seed collected in the larger collections, the resulting seedlings are more often than not, untrue to name. Budding and grafting, even most of the species, is by far the safest means of propagation to insure true-to-type material.

There are a few species which have proved that they are parthogenetic, i.e., that seedlings will be true to name almost 100%. These species are *toringoides*, *hupehensis*, *tschonoski* and *sikkimensis*. One new dark red flowered hybrid we have growing at the Arnold Arboretum may prove to be a valued addition to this group after further trials have proved our original findings. Many types of understock are being used. The Experiment Station at Ottawa, Canada, has found that a certain seedling of *Malus robusta* (their *M. robusta* No. 5, originally collected as seed in the Arnold Arboretum) can be mounded and stooled easily. It is being used as a dwarfing understock for apples, but might have possibilities as a uniform understock for the crab apples. *Malus robusta* seedlings have proved most successful also.

The following 42 crab apples are an excellent group to represent the 200 being grown. Perhaps even this group of 42 should be cut in half! However, the plants in this list have everything from weeping habit to fruit that remains all winter; from double flowers over 2" in diameter to reddish foliage and a few even have autumn color! Of course, each gardener may have his own pet variety which is chosen to grow for one reason or another, but look these over and if possible, make your first selections from this group.

(D=flowers double; SD=flowers semi-double; Measurements=diameter of flowers)

BEST FOR FLOWER (figures refer to flower size)

arnoldiana; pink buds, fading white, 2" in diameter

atrosanguinea; red, 1 $\frac{1}{4}$ " in diam.

baccata; white, 1-1 $\frac{1}{2}$ " in diam.

“ gracilis; white, 1 $\frac{3}{8}$ " in diam.

“ mandshurica; white, 1 $\frac{1}{2}$ " in diam., first to bloom

D coronaria “Charlottae”; pink, 2" in diam., one of latest to flower

“Cowichan”; purplish red, 1 $\frac{3}{4}$ " in diam.

D “Dorothea”; pale pink, 2" in diam., bloom annually

- “Excellenz Thiel”; pink buds, white flowers, $1\frac{3}{4}$ " in diam.
 “Flame”; pink buds, flowers fading white
 floribunda; red buds, flowers fading white, $1-1\frac{1}{2}$ " in diam.
 D “Frau Luise Dittman”; pink, $1\frac{1}{4}$ " in diam.
 D halliana parkmani; deep pink, $1\frac{1}{4}$ " in diam.
 “ spontanea; pink buds, white flowers, $1\frac{3}{8}$ " in diam.
 “Hopa”; purplish red, $1\frac{1}{2}$ " in diam.
 hupehensis; pale pink buds, flowers fading white, $1\frac{1}{2}$ " in diam.
 D ioensis plena; pink, 2" in diam., one of last to flower
 D “Katherine”; light pink fading white, $2\frac{1}{4}$ " in diam.
 D magdeburgensis; pink, $1\frac{1}{2}$ " in diam.
 micromalus; pink, $1\frac{1}{2}$ " in diam.
 “Oekonomierat Echtermeyer”; purplish red, $1\frac{1}{2}$ " in diam.
 D “Prince Georges”; light pink, 2" in diam., one of last to flower
 SD purpurea aldenhamensis; purplish red, $1\frac{3}{4}$ " in diam.
 “ lemoinei; red, the darkest of any, $1\frac{1}{2}$ " in diam.
 “Redfield”; carmine bud, dull pink flowers
 “Redflesh”; “ “ “ “ $1\frac{3}{4}$ " in diam.
 “Red Silver”; purplish red, $1\frac{1}{2}$ " in diam.
 robusta persicifolia; white, $1\frac{1}{2}$ " in diam.
 “Rosseau”; purplish red, $1\frac{3}{4}$ " in diam, latest of Preston hybrids
 D scheideckeri; pale pink, $1\frac{1}{2}$ " in diam.
 sieboldi arborescens; pink buds, flowers fading white, $\frac{3}{4}$ " in diam., one of
 last to flower
 “Sissipuk”; purplish red, $1\frac{1}{8}$ " in diam.
 D spectabilis riversi; pink, 2" in diam.
 zumi calocarpa; pink buds, white flowers, 1" in diam.

BEST FOR FRUITS

(Measurements refer to the size of fruit)

- arnoldiana; yellow and red, $\frac{5}{8}$ "
 baccata; red or yellow, $\frac{3}{8}$ "
 “ gracilis; red, $\frac{3}{8}$ "
 “ mandshurica; yellow to orange, $\frac{5}{8}$ "
 “Bob White”; yellow, $\frac{5}{8}$ ", fruit remains all winter
 brevipes; red, $\frac{3}{8}$ ", fruit colors early
 “Cowichan”; purplish red, $1\frac{3}{4}$ ", annual bearer
 dawsoniana; yellow green and reddish, 1" long and $\frac{1}{2}$ " wide
 “Dolgo”; bright red, $1\frac{1}{4}$ ", one of earliest to fruit
 “Dorothea”; bright yellow, $\frac{5}{8}$ ", annual bearer
 “Flame”; bright red, $\frac{3}{4}$ ", does well in colder areas
 floribunda; yellow and red, $\frac{3}{8}$ "

“Frau Luise Dittman”: yellow, 1"

“Hopa”: orange and red, $\frac{3}{4}$ "

purpurea aldenhamensis; purplish red, 1"

“ *lemoinei*; purplish red, $\frac{5}{8}$ "

“Redfield”: red, $1\frac{3}{8}$ "

“Redflesh”: red, $1\frac{1}{2}$ "

robusta: red and yellow, $\frac{3}{4}$ - $1\frac{1}{2}$ ", varies considerably

“ *persicifolia*; red, $\frac{3}{4}$ "

“Rousseau”: rosy red, $\frac{1}{2}$ -1", annual bearer

scheideckeri; yellow to orange, $\frac{5}{8}$ "

“Sissipuk”: purplish red, $\frac{3}{4}$ ", annual bearer, fruits remain all winter
toringoides; pear-shaped, yellow and red, $\frac{3}{4}$ "

zumi calocarpa; bright red, $\frac{1}{2}$ ", fruit remains all winter

BEST FOR FORM

arnoldiana; dense mounded

baccata gracilis; branches pendulous

brevipes; low, bush-like

“Excellenz Thiel”: pendulous branchlets

floribunda; dense, mounded

halliana spontanea; dense, fountain-like

hupehensis; picturesque, fan-shaped

micromalus; densely upright

“Oekonomierat Echtermeyer”: pendulous branches

sargenti; lowest of all, mound-like

DUAL PURPOSE

(ornamental plus usable fruits)

“Cowichan”

“Dolgo”

“Hopa”

“Redfield”

“Redflesh”

“Red Silver”

WITH COLORED FOLIAGE

atrosanguinea; dark glossy green

“Cowichan”: reddish green

halliana parkmani; very dark green

“Oekonomierat Echtermeyer”: bronze green

purpurea aldenhamensis; reddish green

“ *lemoinei*; reddish green

“Redflesh”: greenish bronze

“Red Silver”: reddish

“Rousseau”: reddish green

“Sissipuk”: reddish green

DONALD WYMAN

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A SPRING WALK THROUGH THE ARNOLD ARBORETUM

THE Arnold Arboretum of Harvard University is fast approaching its best today. Azaleas, crab apples, lilacs, and hundreds of other plants are vying with each other to attract attention. The spring, a most peculiar one, at first, with advanced blooming dates, but later, because of several weeks of cold weather, the blooming of many species was retarded so that today the season is just about "on time."

The Arnold Arboretum, established in 1872, has long been outstanding in the introduction of new plants from all parts of the world. Many of its introductions are now common in nurseries throughout the land. At present there are approximately 5,000 different species and varieties of woody plants growing within its borders. The famous garden of woody plants is not the only important feature of the Arboretum. It also maintains a library of more than 50,000 volumes dealing chiefly with woody plants, and an herbarium of 650,000 mounted specimens, limited to woody plants. The garden, the library and the herbarium, each one of which has earned world renown in its own field, all constitute the Arnold Arboretum; and these are supplemented by the greenhouse laboratories.

Time does not permit a thorough examination of each one of these parts of the Arboretum. The garden of plants, made so famous by the painstaking effort of its first director, Charles Sprague Sargent, and also because of the many new plants it introduced through the efforts of Ernest H. Wilson, is now at its prime.

The first color to be noted as one enters the Jamaica Plain gate and passes the Administration Building, is a planting of various azaleas beside the road. Beyond the azalea border a walk through the woods is most invigorating for here are planted hundreds of the torch azalea (*Rhododendron obtusum kaempferi*) one of the many outstanding ornamental plants the Arnold Arboretum has introduced to this country. Walking through the famous collection of over 100 different kinds of maples, the sentry maple (*Acer saccharum monumentale*) and the columnar form

of the red maple are prominent. To the average visitor the maples are merely a group of common trees, but on close examination one is surprised at the large number which have been collected from other parts of the world and which can be grown in this climate. The maple collection merely exemplifies what is true of many other groups of plants, namely that many species and varieties are growing in the Arnold Arboretum, not all with outstanding ornamental value but with some of considerable merit that have been grown and offered for sale by commercial nurseries.

Leaving the maples, one comes into the shrub collection, containing nearly 800 different kinds of shrubs, growing in long lines where they can be readily cared for and where each group of plants is kept growing fairly close together. This affords an excellent opportunity for comparing the different species and varieties in a genus. The better honeysuckles, quinces, spireas, currants and rose species will be found growing here. Special attention might be given the yellow roses shortly to be in bloom. *Rosa primula* is first to bloom, closely followed by *R. hugonis*. Many of the quinces are still in flower and it is interesting to note the wide diversity of flower sizes and colors among these old-fashioned favorites. Some of the currants (*Ribes sp.*) and spireas are also in full bloom.

Walking past the bank of sprawling forsythias (containing 19 different kinds) it is hard to realize that included in the collection of lilacs beyond are over 450 different varieties and species. The beautybush on the left of the road beyond the lilacs is one of the many plants the Arnold Arboretum has introduced into cultivation. It is just now coming into flower. Before 1922 it was indeed rare in nurseries although it had been growing continuously in the Arboretum since 1907. Now it is available from almost every nursery in the country.

On the right of the road where it turns up Bussey Hill, is the viburnum collection some of which are now in flower. These serviceable plants cannot be recommended too often for they are of value when in flower as well as when their bright colored fruits and brilliant autumn foliage is on display in the fall.

Ascending Bussey Hill, past the *Euonymus* collection on the left, there are some *Prunus* species and varieties, some beach plums (*Prunus maritima*); and on the right the magnificent oak collection. At the top of Bussey Hill one can look across to Hemlock Hill, now showing material damage from the results of two hurricanes. In 1938, winds of over 125 miles per hour velocity felled more than 300 mighty hemlocks, many of which were growing sturdily when George Washington was President of the United States. Many young hemlocks have since been planted, but the blowing over of so many trees on this rocky hill has seriously effected the water-holding capacity of the soil and hence the growth of the remaining mature trees is materially retarded.

Coming down from the top of Bussey Hill, one can walk across an open area and under the large old pines at the end of the path. Many plants have been growing on Bussey Hill, mostly the Asiatic introductions of E. H. Wilson. Some

were so overgrown that it has been imperative to replant or replace many of them. Before leaving this area, one should pause a moment under the cedars of Lebanon, forty-year old trees originally coming to the Arboretum as seeds in 1902 from their northernmost limits in the Anti-Taurus Mountains of Turkey, just north of Syria. Many times this species had been tried, only to succumb in New England's climate, but this strain has proved hardy for more than forty decades, withstanding temperatures of twenty degrees below zero. Close examination will show some of the peculiar cones still remaining on the trees. It takes two years for them to mature.

The native pinxterflower (*Rhododendron nudiflorum*) as well as its close relative *R. roseum* with darker pink flowers, is on the left of the path as one walks back to the road. The brilliant scarlet azalea seen throughout the woods and so gorgeous at the end of this walk under the century old pines is the torch azalea from Japan (*R. obtusum kaempferi*) often referred to by Professor Sargent as the most brilliantly colored of all the Arnold Arboretum introductions. The mauve colored azalea is the Korean azalea (*R. yedoense poukhanense*) another Arboretum introduction. Note how well it goes with the pale lemon yellow flowers of the Warminster broom close by.

Stopping for a few moments at Azalea Path on the way down Bussey Hill, hundreds of azaleas can be seen in full bloom. The first along the path is the royal azalea from Japan (*Rhododendron schlippenbachii*) which is one of those rare azaleas the foliage of which is blessed with autumn color in the fall. Across from this is the hardy form of the silk tree (*Albissia julibrissin rosea*) which the Arboretum introduced from Korea in 1918, and this specimen was grown from the original importation of seeds. The trees that are so common in the southern United States are not so hardy in New England, but this form is. The foliage is very delicate and the interesting, thread-like flowers, begin to appear the middle of July and continue until September. A really unusual tree for this part of the country.

Walking back to the Bussey Hill road and down the hill, one passes the oaks, the mountain ashes, the rockery with several interesting small plants, the hornbeams, and beyond them but mostly unseen from the road, the junipers and yews. Dogwoods (*Cornus florida*) and redbud (*Cercis canadensis*) are evident everywhere and are loaded with flowers this year. Only one or two of the rhododendrons are in flower now, yet the Arboretum has over 200 representatives of the genus *Rhododendron* growing within its borders. The famous bank of mountain laurel will not bloom for at least another two or three weeks.

The hill to the right of the road harbors most of the pinetum where hundreds of evergreens from many parts of the world display their dependable green foliage year in and year out. Pines alone are represented by 54 different species and varieties. The graceful Sargent weeping hemlock to the left of the road has been growing there since 1881. Plants were originally found growing on an estate along the Hudson River of upper New York. This is a splendid specimen and is

another living example of what peculiar forms Mother Nature sometimes creates.

Continuing through the gates and across Bussey Street to the Peters Hill area, one comes to the oldest collection of ornamental crab apples in the country. Here nearly 200 species and varieties of the genus *Malus* are being grown side by side. The trees range in height from the low Sargent crab apple (7-8 feet) to the tall Mandshurian crab which is a standard tree of over 50 feet in height. The peak of the flowering of these interesting and usefully ornamental trees is in the first weeks of May, but some are still in flower. To appreciate them fully, one should return to see their myriads of small brilliant fruits during the late summer and fall.

Time being at a premium, one rushes on past the pinetum once more, being certain to gain a view down Bussey Brook of the splendid native stand of American beeches, and on to the gorgeous planting of a thousand of the torch azaleas on South Street bank, through the propagating units of the Arboretum, glancing at a few of the experimental beds where many interesting experiments are being carried out by Arboretum staff members. There may be only a minute to pause at the unique collection of dwarf evergreen trees, originally imported from Japan many years ago by Larz Anderson and presented to the Arboretum by Mrs. Anderson. Some of these are well over 150 years old. The hedge collection of over 100 different kinds of clipped hedges is always open to close inspection for those who want to choose just the right hedge material for the right place.

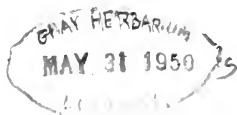
Before finally leaving the Arboretum, one should enter the Forest Hills gate where the majority of visitors first come, walk among the oriental cherry trees (now past bloom for several weeks), and continue to the top of the famous lilac collection, where one cannot but help gain inspiration from walking among these beautiful plants. Plant breeders and home owners for nearly two centuries have been contributing new varieties, and here in the collection, a studied attempt has been made during the past years to grow at least one specimen of every variety which can be obtained. At present there are 450 species and varieties. They commence to bloom about the first week in May with some varieties coming into bloom for a six-week period thereafter. At this time, by far the most numerous are the varieties of the common lilac (*S. vulgaris*) of which there are over 300 varieties being grown here.

The early lilac, the late lilac, the littleleaf lilac that blooms a second time in the fall, the tree lilac and the Preston lilac—all are here and growing well. If lilacs are one's chief interest, this collection is the place to study them. Even the amateur is enthusiastic, for this large collection is living proof of the great efforts which have gone into the breeding and selection of these plants by hundreds of people throughout the north temperate zone.

There is no better way to finish one's May visit to the Arboretum than to linger among the lilacs, and absorb to the full their fragrance and beauty.

DONALD WYMAN

ARNOLDIA



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THE CONTROL OF PLANT DEVELOPMENT WITH MALEIC HYDRAZIDE

MANY species of plants, commonly handled as nursery stock, are likely to develop undesirable soft shoots when exposed to high temperatures following a long period in cold storage. Such development, as well as the cost of cold storage facilities, might be avoided if nursery stock could be kept dormant by spraying nursery plants in fall or early spring. Our preliminary experiments have indicated that maleic hydrazide, which is *effective as a low temperature spray on dormant nursery stock*, may be a useful material for this purpose.

The effect of maleic hydrazide was first described by Schoene and Hoffman (5) in 1949. Dilute solutions of maleic hydrazide were found to inhibit growth of tomatoes and various grasses. Growth was inhibited for a few days to several months depending upon the concentration of the chemical. Knott (2) found that growth in a *Pyracantha* hedge could be controlled by spraying with a 0.2 to 0.5 percent solution. White and Kennard (6) used a 0.045 percent solution which delayed flowering in raspberries without any deleterious effect on subsequent fruit set. Plants sprayed on April twenty-seventh, when leaflets had expanded about one-half inch, set fruit from sixteen to twenty-three days later than untreated plants. Vegetative growth was temporarily inhibited but both treated and untreated plants had attained a similar development by midsummer. The crop was equally good in both instances. Miller and Erskine (3) have prevented fruit set in *Ginkgo biloba* by spraying blooming trees with 0.1 percent maleic hydrazide. Naylor (4) sprayed corn plants thirty to forty inches high with 0.025 percent solution, thus producing male sterile plants with normal ears. Currier and Crafts (1) have found that a 0.2 percent spray killed young plants of Johnson and water grasses, but did not affect cotton plants sixteen inches high.

Maleic hydrazide was sent to us for experimental purposes by Dr. John W. Zukel, Naugatuck Chemical Division, United States Rubber Company, Naugatuck,

Connecticut, as a solution containing 30 percent of the active ingredient in the form of the diethanolamine salt. The percentages of the dilute solutions are based upon the actual weight of the active ingredient dissolved in 1 liter of distilled water. Thus the 0.6 percent solution was prepared by adding 20 grams of the formulation, containing 6 grams of the active ingredient, to one liter of distilled water. Since the formulation has a specific gravity of 1.2, a substantially similar solution may be prepared by dissolving 16.6 milliliters of the formulation in one liter of distilled water.

The material may be applied as a spray or by immersing the stems in the solution. The effectiveness of the spray treatments is increased by adding a wetting agent. Maleic hydrazide should be handled with the customary precautions which apply to all new chemicals. Treated food crops should not be eaten until a complete toxicological evaluation is available.

Experimental Results

On January twenty-third, field grown, dormant plants of several rose varieties were sprayed out-of-doors at a temperature of about 43° F. and at high relative humidity. At the same time corresponding plants were selected as controls. About five hours after spraying, suitable branches were removed from these plants and made up into seven-inch cuttings. These cuttings were then planted in sand and placed in a warm greenhouse. The results with *Rosa dilecta* "Talisman," sprayed with 0.3 percent solution, are illustrated in Plate IX. Treated cuttings of this variety were effectively inhibited for twenty-eight days following treatment. At this time several dead cuttings had appeared in both treated and control lots and the cuttings were subsequently discarded. "Paul's Scarlet" climber was inhibited by spraying with 0.15 percent solution, but eleven weeks later the treated cuttings had only produced abnormally elongated leaves and the material was discarded. "Dorothy Perkins" climber, however, which received the same treatment, was effectively inhibited for about six weeks and after eleven weeks, the treated cuttings had resumed apparently normal growth, including good roots and vigorous, leafy shoots. Similar results were obtained with cuttings of *Rosa multiflora* "thornless" sprayed with 0.15 and 0.075 percent solutions. There were no apparent differences between the two concentrations.

Both dormant and actively growing plants of *Rosa multiflora* "thornless" were seriously injured by a 0.6 percent spray treatment. Some of these dormant plants were packaged with moist moss and stored either in a warm greenhouse or in cold storage at 40° F. None of the plants treated with 0.6 percent have resumed normal growth and many of them were killed by the treatment. The treatment, however, is effective at temperatures of 40° F. and it is entirely possible that a suitable concentration would be very useful in preventing premature bud development in stored rose bushes.

Several species of *Prunus* were inhibited by maleic hydrazide treatment, both

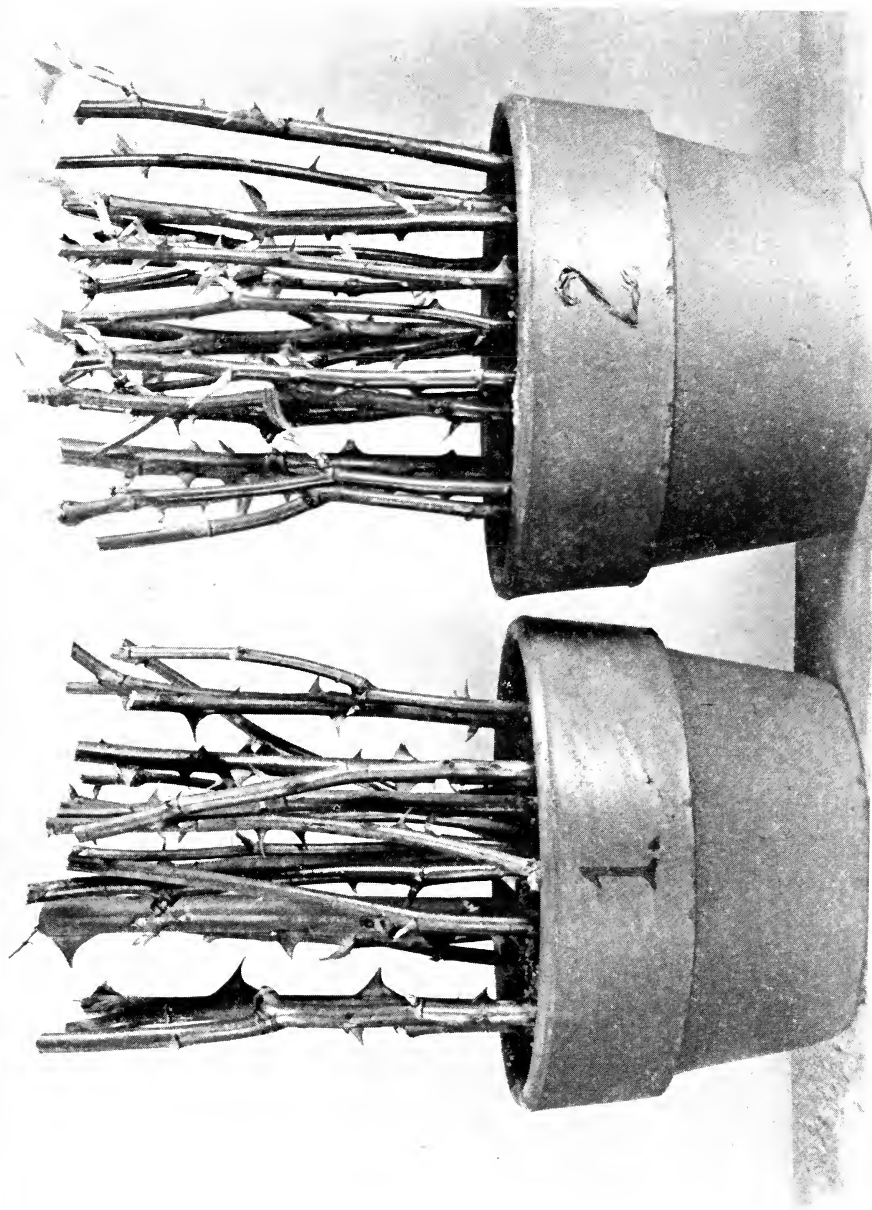


PLATE IX

Rosa dillecta "Talisman," photographed February 2, 1950, after nine days in a warm greenhouse. Lot 1, cuttings collected from a plant sprayed out-of-doors with 0.3 percent maleic hydrazide; Lot 2, cuttings from control plant.

Photo by Heman Howard

by spraying and by basal immersion of the stems. Dormant nursery seedlings of *Prunus* "Mazzard" have remained alive for eleven weeks following spraying with a 0.6 percent solution, but it seems unlikely that these plants will ever resume normal growth. Twenty-five cuttings, made from a dormant plant of *Prunus persica* "Rutgers Greenleaf," sprayed out-of-doors with 0.3 percent solution, were definitely inhibited for several weeks. A few cuttings were killed by the treatment, but many resumed normal growth including both roots and shoots. *Prunus sargentii* and *P. yedoensis* seedlings were inhibited by a 0.3 percent spray. Recovery of some individual plants has been fair to good in both instances.

Scions of *Malus pumila* "MacIntosh" were inhibited by spraying with 0.6 percent solution. The treated scions were grafted on roots of untreated apple seedlings. Although the effect of this chemical is systemic rather than localized, it is apparently possible to secure considerable inhibition of buds and yet permit some degree of callus formation. An application of indolebutyric* acid, at the point of graft union, appears to have intensified the inhibiting effect of the maleic hydrazide. Small-scale out-of-door spraying of *Malus pumila* "Delicious," using 0.075 percent maleic hydrazide, has not resulted in delayed flowering when the treated branches were removed from the tree and forced in a warm greenhouse.

Well-budded branches of *Forsythia* were brought into the greenhouse for forcing in late January. Maleic hydrazide treatment had little effect on the time of flowering, but the duration of flowering was prolonged. In one lot, treated with 0.15 percent solution by soaking the basal part of the stems for sixteen hours, flowers borne on the treated branches remained in good condition for about a week longer than those on the controls. The flowering life of cut roses was also lengthened by using a 0.03 percent solution as an overnight soaking treatment. It is probable that the life of other cut flowers could be prolonged by similar treatments.

Maleic hydrazide, as a 0.3 percent spray on dormant potted plants, has effectively inhibited vegetative growth and has delayed flowering in *Vaccinium corymbosum* "Cabot" and "Pioneer." One treated plant of the variety "Cabot," sprayed on February third and subsequently placed in a warm greenhouse, began to flower on April fourth, fourteen days later than the corresponding control. On April fourteenth, this treated plant was in full bloom while only an occasional flower remained on the untreated control. The treated plant still showed evidence of vegetative inhibition, but it had developed numerous apparently normal leafy shoots. Although both treated and control plants produced an abundance of apparently normal flowers, there was practically no fruit set in either lot. This lack of fruit set may be due to poor pollinating conditions in the greenhouse.

Potted plants of *Picea*, *Tsuga*, *Pinus* and *Larix* were sprayed with 0.6 percent maleic hydrazide in greenhouse conditions. Growth was inhibited in all cases,

*Hormodin 1.

but at the time of writing there has been no resumption of normal growth. *Larix* and *Tsuga* are apparently more tolerant of maleic hydrazide treatment than are *Picea* and *Pinus*.

Actively growing potted plants of *Rhododendron mucronatum* (*Azalea ledifolia alba*) were severely injured by spraying with 0.6 percent solution on January twenty-first. On April fourteenth, however, these plants were forming new roots and there was considerable evidence of renewed bud activity.

Syringa amurensis japonica, *S. vulgaris*, *Betula papyrifera* and *B. lenta* have not responded markedly to maleic hydrazide treatment in the conditions of these experiments.

Conclusion

The control of vegetative and floral development has many applications in horticulture: the delay of flowering in early blooming plants; the destruction of flowers in plants which produce unwanted fruits or pollen; the selective killing of weeds; the prolongation of the life of cut flowers; and the retardation of dormant nursery stock. Although maleic hydrazide has given us some promising results in the control of floral and vegetative development, these results are based on limited trials with relatively small numbers of plants. Definite practical recommendations must await the outcome of further studies.

RICHARD H. FILLMORE

BIBLIOGRAPHY

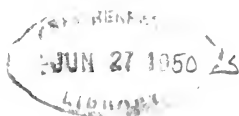
1. Currier, H. B. and A. S. Crafts
1950. Maleic hydrazide, a selective herbicide. *Science*, Vol. III, No. 2786: 152-153.
2. Knott, J. E.
1949. The use of maleic hydrazide for controlling the growth of a *Pyracantha* hedge. Unpublished paper presented at the Forty-sixth Annual Meeting, A. S. H. S., at the Hotel Schroeder, Milwaukee, Wisconsin, on October 27, 1949. See also, Knott, J. E., 1950. *Agricultural Chemicals* 5: 53-55.
3. Miller, Richard R. and Donald Erskine
1949. The prevention of fruit formation on some ornamental trees. *Proc. of the 25th National Shade Tree Conference*: 88-100.
4. Naylor, Aubrey W.
1950. Observations on the effect of maleic hydrazide on the flowering of tobacco, maize and cocklebur. *Proc. National Academy of Science*, Vol. 36, No. 4: 230-232.
5. Schoene, D. L. and Otto L. Hoffman
1949. Maleic hydrazide, a unique growth regulant. *Science*, Vol. 109, No. 2881: 588-590.
6. White, David G. and William C. Kennard
1949. The use of maleic hydrazide to delay blossoming of fruits. Unpublished paper presented at the Forty-sixth Annual Meeting, A.S.H.S., at the Hotel Schroeder, Milwaukee, Wisconsin, on October 26, 1949. See also White, David G., 1950. Blossoming of fruits delayed by maleic hydrazide. *Science*, March 24, 1950: 303.

CABOT FOUNDATION PUBLICATION

The Harvard Forest has recently published an enlarged edition of its 1947 publication, "The Use of Auxins in the Rooting of Woody Cuttings," by Kenneth V. Thimann and Jane Behnke-Rogers. (Maria Moors Cabot Foundation Publication No. 1)

It is a paper-bound volume which contains 344 pages of valuable information on the rooting of cuttings. The information for each species is presented in convenient tables under such headings as the type of cutting, the influence of wounding, the percent rooted both with and without auxin (hormone) treatment, and the time required for rooting. There is a bibliography of 313 references for those who require information which does not appear in the tables. This book is frequently used in the propagating work at the Arnold Arboretum. It may be obtained from the Harvard Forest, Petersham, Massachusetts. The price is one dollar plus postage.

ARNOLDIA



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ORDER OF BLOOM

ALTHOUGH the actual dates on which certain plants bloom will vary from year to year, the sequence will remain the same. Lilacs will always begin to flower a little after some of the crab apples have reached their peak; most of the rhododendrons will follow the lilacs, and the mock oranges will follow the rhododendrons. Records of the sequence and the time of bloom of the many flowering trees and shrubs in the Arnold Arboretum have been kept over a long period of years and in the following lists some of them are recorded in their sequence and in the approximate time when they can be expected to flower normally.

It should be stressed that some shrubs especially those with double flowers will remain in flower longer than others and hence can be used effectively in gardens with plants that are noted as blooming later. Still others are effective in flower bud and might be planted with varieties blooming earlier. Local studies along this line should prove most interesting to individual gardeners.

In this connection it might be of interest to note the different times at which *Cornus florida* blooms throughout the country. This tree has a wide habitat over the eastern United States and is so beautiful that it is highly valued as an ornamental wherever it is bud hardy. It can be expected to bloom in the following places at the approximate times mentioned.

Glen St. Mary, Florida	Mid-February
Augusta, Georgia	Late March
St. Louis, Missouri	Early April
Ashville, North Carolina	Mid-April
Washington, D.C.	Late April
Lexington, Kentucky	" "
Columbus, Ohio	Early May

Philadelphia, Pennsylvania	Early May
London, England	“ “
Chicago, Illinois	Mid-May
Detroit, Michigan	“
Rochester, New York	“
Boston, Massachusetts	“
Seattle, Washington	“
Portland, Maine	Late May

One other series of dates has proved interesting at the Arnold Arboretum. There is a weeping willow tree adjacent to the Administration Building which turns green almost over night when the weather is just right. Since the bud scales of willows are valvate, the bud scales drop when the temperatures are high enough and the young foliage quickly swells and gives the tree a green appearance. Since this happens rapidly—almost overnight—the dates on which this occurs afford a valuable commentary on the earliness or lateness of the season. The following are the dates for the past eleven years.

1940	May 1
1941	April 15
1942	“ 6
1943	“ 28
1944	May 1
1945	March 27
1946	“ 27
1947	April 14
1948	“ 5
1949	“ 4
1950	“ 28

The following order of bloom is applicable in localities other than New England. If local blooming dates of a few key plants are noted and the differences checked with those given in the following sequence, then all the dates can be correspondingly shifted and the sequence can thus be adapted to local climatic conditions.

Order of Bloom

(All plants in the following lists are growing in the Arnold Arboretum under practically the same soil and climatic conditions and have bloomed together in the following sequence.)

February	March
<i>Hamamelis vernalis</i>	<i>Acer saccharinum</i>

Corylus species
 Hamamelis japonica
 " mollis
 Salix species
 Snowdrop and Crocus

Early April

Acer rubrum
 Alnus incana
 " rugosa
 Cornus mas
 " officinalis
 Daphne mezereum
 Erica carnea
 Forsythia ovata
 Jasminum nudiflorum
 Lonicera praeflorens
 Populus species
 Prunus davidiana
 Ulmus americana
 Viburnum fragrans

Mid-April

Abeliophyllum distichum
 Acer negundo
 Betula species
 Cercidiphyllum japonicum
 Corylopsis species
 Dirca palustris
 Epigaea repens
 Forsythia europaea
 " intermedia varieties
 " suspensa sieboldi
 " viridissima
 Lindera benzoin
 Lonicera fragrantissima
 " purpusi
 " standishi
 Pieris japonica
 Rhododendron dauricum
 " mucronulatum
 Shepherdia argentea

Late April

Acer circinatum
 " diabolicum purpurascens
 " platanoides
 Amelanchier canadensis
 " laevis
 " spicata
 Buxus microphylla
 Chamaedaphne calyculata
 Euptelea polyandra
 Lonicera altmanni pilosiuscula
 " tenuipes
 Magnolia denudata
 " kobus
 " " borealis
 " salicifolia
 " stellata
 Malus baccata mandshurica
 Myrica gale
 Pieris floribunda
 Poncirus trifoliata
 Prunus armeniaca
 " canescens
 " cerasifera
 " concinna
 " cyclamina
 " dasycarpa
 " domestica
 " incisa and varieties
 " juddi
 " mandshurica
 " nipponica
 " sargentii
 " subhirtella and varieties
 " tomentosa
 " triloba
 " yedoensis
 Spiraea prunifolia
 Vinca minor and varieties

Early May

Acer campestre



PLATE X

Viburnum tomentosum mariesi. This variety has larger flowers and fruits than the commonly grown Doublefile Viburnum (*V. tomentosum*).

Acer saccharum
Amelanchier grandiflora
 " *humilis*
 " *sanguinea*
 " *stolonifera*
Andromeda glaucophylla
 " *polifolia*
Berberis dictyophylla
Carpinus caroliniana
Chaenomeles japonica and varieties
 " *lagenaria* and varieties
Crataegus arnoldiana
Cytisus decumbens
 " *elongatus*
 " *beani*
Dandelion
Enkianthus perulatus
Exochorda giraldi
Ledum groenlandicum
Lonicera canadensis
 " *coerulea*
 " *saccata*
Magnolia soulangeana and varieties
Mahonia species
Malus adstringens and varieties
 " *arnoldiana*
 " *astracanica*
 " *atrosanguinea*
 " *baccata*
 " *brevipes*
 " *floribunda*
 " *halliana* and varieties
 " *hupehensis*
 " *micromalus*
 " *prunifolia* and varieties
 " *pumila niedzwetzka*
 " *purpurea* and varieties
 " *robusta* and varieties
 " *scheideckeri*
 " *soulardi*
 " *spectabilis* and varieties
 " *sylvestris*

Malus zumi and varieties
Myrica pensylvanica
Narcissus
Nemophanthus mucronatus
Orixa japonica
Osmaronia cerasiformis
Pachysandra terminalis
Phlox subulata
Primula elatior superba
 " *polyantha*
Prinsepia sinensis
Prunus alleghaniensis
 " *americana*
 " *avium*
 " *blireiana* and varieties
 " *glandulosa* and varieties
 " *hortulana*
 " *incana*
 " *institia*
 " *japonica nakai*
 " *maritima*
 " *padus* and varieties
 " *pensylvanica*
 " *persica* and varieties
 " *pumila susquehane*
 " *serrulata* and varieties

(Many double-flowered forms starting to bloom and continuing for two weeks at least, depending on the variety, some being slightly earlier than others.)

Prunus sieboldi
Pyrus communis and varieties
Rhododendron mucronatum
 " *venustum*
Rhus aromatica
Ribes alpinum
 " *aureum*
 " *gordonianum*
 " *odoratum*
Spiraea arguta
 " *thunbergi*

Syringa hyacinthiflora and varieties
 “ oblata dilatata
 Tulips
 Viburnum alnifolium
 “ buddleifolium
 “ burejaeticum
 Violets
 Xanthorhiza simplicissima
 Zanthoxylum americanum

Mid-May

Acer palmatum
 Aesculus arguta
 “ bushi
 “ carnea
 “ glabra
 “ hippocastanum
 “ neglecta
 Akebia quinata
 “ trifoliata
 Alyssum gemonense
 “ saxatile
 Amelanchier amabilis
 Amelasorbus jacki
 Aristolochia manshuriensis
 Berberis dielsiana
 “ julianae
 “ koreana
 “ stenophylla
 “ thunbergi and varieties
 “ vernae
 “ vulgaris
 Calycanthus floridus
 Caragana arborescens
 “ frutex
 “ sophoraefolia
 Cercis canadensis
 “ chinensis
 Cornus florida
 Cydonia oblonga
 Cytisus praecox
 “ purgans

Cytisus purpureus
 “ scoparius
 Daphne altaica
 “ caucasica
 “ cneorum
 Deutzia grandiflora
 Davidia involuerata
 Elaeagnus multiflora
 “ umbellata
 Enkianthus campanulatus
 Euonymus alata
 “ latifolia
 Exochorda korolkowi
 “ macrantha
 “ racemosa
 Fothergilla species
 Halesia carolina
 “ monticola
 Iberis tenoreana
 Kerria japonica
 Leitneria floridana
 Lonicera alpigena
 “ bella
 “ chrysantha
 “ muendeniensis
 “ muscaviensis
 “ syringantha
 “ “ wolfi
 “ thibetica
 “ xylosteum
 Magnolia fraseri
 “ liliflora nigra
 Malus bracteata
 “ glaucescens
 “ ioensis
 “ sargentii
 “ sieboldi and varieties
 Papaver orientale
 Paulownia tomentosa
 Prinsepia uniflora
 Prunus cerasus
 “ maackii



PLATE XI

Cyrilla racemiflora, the native American Cyrilla is an interesting shrub blooming in mid-July.

Prunus virginiana
Quercus species
Rhododendron albrechtii
 " *canadense*
 " *carolinianum*
 " *fraseri*
 " *luteum*
 " *obtusum amoenum*
 " " *arnoldianum*
 " " " *"Hinodegiri"*
 " " *japonicum*
 " " *kaempferi*
 " *racemosum*
 " *reticulatum*
 " *schlippenbachii*
 " *vaseyi*
 " *yedoense*
 " " *poukhanense*

Rhodotypos scandens

Ribes sanguineum

Sambucus pubens

Sibiraea laevigata

Sorbus aucuparia

Spiraea cinerea

 " *gemmata*
 " *hypericifolia*
 " *inflexa*
 " *media*
 " *mollifolia*
 " *oxyodon*
 " *pikoviensis*
 " *prunifolia plena*
 " *pubescens*

Syringa vulgaris and varieties

(With over 300 varieties, it is impossible to list them here as early, medium and late, although some might be so listed.)

Vaccinium angustifolium laevifolium

Viburnum bitchuense

 " *burkwoodi*
 " *carlesi*

Viburnum juddii

 " *lantana*

Weigela "Conquerant"

 " " *"Fleur de Mai"*

 " " *"Floreale"*

 " *florida venusta*

 " " *"Gracieux"*

Wisteria venusta and varieties

Late May

Acer ginnala

Aronia arbutifolia

 " *melanocarpa*

 " *prunifolia*

Asimina triloba

Berberis amurensis

 " *circumserrata*

 " *gagnepainii*

 " *verruculosa*

Berchemia racemosa

Buttercup

Caragana maximowicziana

Celastrus flagellaris

 " *orbiculata*

 " *scandens*

Cornus alternifolia

 " *controversa*

 " *stolonifera*

Coronilla emeroides

Cotoneaster adpressa

 " *apiculata*

 " *divaricata*

 " *foveolata*

 " *nitens*

 " *racemiflora*

Crataegus crus-galli

 " *oxyacantha*

 " " *pauli*

 " *pruinosa*

 " *punctata*

 " *succulenta*

Daphne giraldi



PLATE XII

Halesia monticola, the Silver Bell tree, blooms in mid-May.

Daylilies	<i>Prunus laurocerasus schipkaensis</i>
<i>Deutzia candelabrum</i>	“ <i>serotina</i>
“ <i>gracilis</i>	<i>Rhamnus cathartica</i>
“ <i>kalmiaeflora</i>	<i>Rhododendron atlanticum</i>
“ <i>lemoinei</i> and varieties	“ <i>catawbiense</i> “ <i>Boule</i>
“ <i>rosea</i> and varieties	<i>de Neige</i> ”
<i>Dipelta floribunda</i>	<i>Rhododendron catawbiense</i> “ <i>Charles</i>
<i>Enkianthus deflexus</i>	<i>Dickens</i> ”
“ <i>subsessilis</i>	<i>Rhododendron catawbiense</i> “ <i>Mont</i>
<i>Fendlera wrighti</i>	<i>Blanc</i> ”
<i>Fontanesia fortunei</i>	<i>Rhododendron fortunei</i> “ <i>Duke of</i>
<i>Gaylussacia baccata</i>	<i>York</i> ”
<i>Genista pilosa</i>	<i>Rhododendron gandavense</i> hybrids
<i>Iberis sempervirens</i>	“ <i>japonicum</i>
<i>Juglans sieboldiana</i>	“ <i>molle</i> hybrids
<i>Laburnum species</i>	“ <i>nudiflorum</i>
<i>Leucothoe racemosa</i>	“ <i>roseum</i>
<i>Lonicera amoena</i>	“ <i>smirnowi</i>
“ <i>korolkowi</i>	<i>Robinia ellioti</i>
“ <i>maacki</i>	“ <i>fertilis</i>
“ <i>maximowiczii sachalinensis</i>	“ <i>kelseyi</i>
“ <i>morrowi</i>	“ <i>slavini</i>
“ <i>tatarica</i> and varieties	<i>Rosa ecae</i>
<i>Magnolia cordata</i>	“ <i>hugonis</i>
“ <i>soulangeana lennei</i>	“ <i>primula</i>
“ <i>tripetala</i>	“ <i>xanthina</i>
“ <i>virginiana</i>	<i>Rubus deliciosus</i>
“ <i>watsoni</i>	<i>Schisandra chinensis</i>
<i>Malus angustifolia</i>	<i>Smilax rotundifolia</i>
“ <i>coronaria</i>	<i>Spiraea blumei</i>
“ “ <i>charlottae</i>	“ <i>cantonensis</i>
“ <i>ioensis plena</i>	“ <i>multiflora</i>
“ <i>toringoides</i>	“ <i>nipponica</i>
<i>Neillia sinensis</i>	“ “ <i>rotundifolia</i>
<i>Paeonia suffruticosa</i>	“ <i>trilobata</i>
<i>Petteria ramentacea</i>	“ <i>vanhouttei</i>
<i>Philadelphus hirsutus</i>	<i>Staphylea colchica</i>
“ <i>schrenkii jackii</i>	“ <i>trifolia</i>
<i>Photinia villosa</i>	<i>Symplocos paniculata</i>
<i>Physocarpus amurensis</i>	<i>Syringa chinensis</i>
“ <i>monogynus</i>	“ <i>julianae</i>
<i>Potentilla fruticosa</i> and varieties	“ <i>meyeri</i>

Syringa microphylla
 “ *persica*
 “ *pinetorum*
 “ *potanini*
 “ *pubescens*
 “ *velutina*
 “ *wolffi*
 “ *yunnanensis*
Tamarix parviflora
Thymus serpyllum
Vaccinium corymbosum
Viburnum lentago
 “ *macrocephalum sterile*
 “ *opulus roseum*
 “ *rafinesquianum*
 “ *rhytidophyllum*
 “ *rufidulum*
 “ *sieboldi*
 “ *tomentosum*
 “ “ *sterile*
 “ *trilobum*
 “ *wrightii*
Weigela “*Dame Blanche*”
 “ “*Lavallei*”
Wisteria floribunda and varieties
 “ *formosa*
 “ *sinensis* and varieties

Early June

Abelia engleriana
Actinidia arguta
Buddleia alternifolia
Ceanothus ovatus
Chionanthus retusus
 “ *virginicus*
Cladrastis lutea
Cornus alba
 “ *kousa*
 “ *rugosa*
Cotinus coggygria
Daphne pontica
Decaisnea fargesii

Elaeagnus angustifolia
Euonymus atropurpurea
 “ *bungeana*
Genista hispanica
 “ *tinctoria*
Halimodendron halodendron
Helianthemum nummularium
Hydrangea petiolaris
 “ *xanthoneura wilsoni*
Idesia polycarpa
Ilex opaca
Indigofera amblyantha
Jamesia americana
Kolkwitzia amabilis
Leucothoe catesbaei
Lonicera ruprechtiana
Magnolia sieboldi
Periploca graeca
 “ *sepium*
Phellodendron amurense
Philadelphus “*Banniere*”
 “ *caucasicus*
 “ “*Cole's Glorious*”
 “ “*Conquete*”
 “ *coronarius*
 “ “*Coupe d'Argent*”
 “ *floridus*
 “ *laxus*
 “ *magdalenae*
 “ “*Manteau de Hermine*”
 “ *maximus*
 “ *nepalensis*
 “ *pekinensis*
 “ “*Rosace*”
 “ *tomentosus*
Physocarpus intermedius
 “ *opulifolius*
Rhamnus davurica
 “ *frangula*
Rhododendron arbutifolium
 “ *calendulaceum*
 “ *catawbiense* and vars.

- Rhododendron ferrugineum*
 " *laetevirens*
 " *minus*
 " "Mrs. C. S. Sargent"
 " "Purpureum Grandi-
 florum"
Rhus potanini
Robinia hartwigi
 " *hispida*
 " *pseudoacacia*
Rosa acicularis
 " *arnoldiana*
 " *bella*
 " *blanda*
 " *foetida bicolor*
 " *harisoni*
 " *l'heritierana*
 " *roxburghi*
 " *rubrifolia*
 " *rugosa* and varieties
 " *spinosissima* and varieties
 " *willmottiae*
Sassafras albidum
Sophora viciifolia
Spiraea blanda
 " *chamaedryfolia*
 " *henryi*
 " *trichocarpa*
 " *wilsoni*
Staphylea pinnata
Styrax americana
 " *japonica*
 " *obassia*
Syringa henryi and varieties
 " *josikaea* and varieties
 " *komarowi*
 " *prestoniae* and varieties
 " *reflexa*
 " *sweginzowi*
 " *tomentella*
 " *villosa*
Vaccinium stamineum
- Viburnum cassinoides*
 " *dentatum*
 " *dilatatum* and varieties
 " *hupehense*
 " *lobophyllum*
 " *opulus*
 " *prunifolium*
 " *sargentii*
Weigela florida
 " "Gratissima"
Wisteria macrostachya
- Mid-June**
- Amorpha fruticosa*
 " *glabra*
Castanea pumila
Catalpa speciosa
Ceanothus americanus
Cornus amomum
 " *bretschneideri*
 " *coreana*
 " *racemosa*
Cotinus americanus
Cotoneaster dielsiana
 " *horizontalis*
 " *multiflora*
Crataegus phaenopyrum
Deutzia "Contraste"
 " "Magicien"
 " *magnifica*
Diospyros virginiana
Euonymus europaea
 " *fortunei* vegeta
Gymnocladus dioica
Hydrangea bretschneideri
Ilex glabra
 " *verticillata*
Indigofera decora
 " *kirilowi*
 " *potanini*
Kalmia angustifolia
 " *latifolia*



PLATE XIII

Syringar japonica, the Japanese Snowbell, grows well in the Arboretum.

Ligustrum amurense
 “ ibolium
 “ ibota
 “ obtusifolium
 “ “ regelianum
 “ ovalifolium
 “ vulgare

Liriodendron tulipifera

Lonicera browni

“ iberica
 “ japonica halliana
 “ periclymenum

Lyonia ligustrina

“ mariana

Philadelphus “Albatre”

“ “Argentine”
 “ “Atlas”
 “ “Avalanche”
 “ “Bouquet Blanc”
 “ “Boule d’Argent”
 “ cymosus
 “ “Girandole”
 “ “Glacier”
 “ grandiflorus
 “ “Innocence”
 “ inodorus
 “ lemoinei and varieties
 “ microphyllus
 “ monstrosus
 “ “Mont Blanc”
 “ “Norma”
 “ “Pavillon Blanc”
 “ pubescens
 “ purpurascens
 “ splendens
 “ zeyheri

Pyracantha coccinea lalandi

Rhododendron “Album Elegans”

“ “Grandiflorum”
 “ arborescens

Robinia viscosa

Rosa alba

Rosa arvensis

“ canina
 “ centifolia
 “ damascena
 “ davidi
 “ eglanteria
 “ gallica
 “ helenae
 “ jacksoni
 “ micrantha
 “ moyesi
 “ multiflora
 “ “ cathayensis
 “ virginiana
 “ webbiana

Rubus allegheniensis

Sambucus nigra

Spiraea veitchi

“ watsoniana

Stephanandra incisa

Symphoricarpos albus laevigatus

Syringa amurensis

“ “ japonica
 “ pekinensis

Tilia platyphyllos

Viburnum acerifolium

“ molle

“ pubescens

Weigela “Congo”

“ “Eve Rathke”

Zenobia pulverulenta

Late June

Acanthopanax sieboldianus

Actinidia polygama

Ailanthus altissima

Ceanothus pallidus roseus

Cornus macrophylla

Cotoneaster salicifolia

Deutzia myriantha

“ scabra plena

“ staminea

Diervilla sessilifolia
Dorcnium hirsutum
Genista anglica
Ilex crenata
Indigofera incarnata alba
Itea virginica
Lavandula officinalis
Lonicera henryi
Philadelphus "Belle Etoile"
 " *burkwoodi*
 " "Enchantment"
 " *virginalis* and varieties

Rhododendron maximum
Rhus typhina
Rosa multibracteata
Sambucus canadensis
Schizophragma hydrangeoides
Sorbaria sorbifolia
Spiraea billardi
 " *bumalda* and varieties
 " *douglasi*
 " *japonica*
 " *latifolia*
 " *margaritae*
 " *menziesi*
 " *pyramidata*
 " *tomentosa*
 " *virginiana*

Stephanandra tanakae
Tripterygium regeli

Early July

Buddleia japonica
Callicarpa dichotoma
 " *japonica*
Cytisus nigricans
Holodiscus discolor
Hydrangea arborescens
 " " *grandiflora*
Hypericum kalmianum
 " *patulum henryi*
Lycium species

Maackia amurensis
Marsdenia erecta
Rhododendron viscosum
Rhus glabra
Rosa setigera
Rubus odoratus
Spiraea salicifolia
Stewartia koreana
 " *pseudo-camellia*
Tilia euchlora
 " *petiolaris*
 " *tomentosa*
Viburnum setigerum aurantiacum

Mid-July

Aesculus parviflora
Albizzia julibrissin rosea
Amorpha brachycarpa
 " *canescens*
Ampelopsis aconitifolia
 " *cordata*
Berberis aggregata
Campsis radicans
Clematis jackmani
Cyrilla racemiflora
Diervilla lonicera
Hydrangea cinerea
 " *paniculata praecox*
 " *quercifolia*
 " *radiata*
 " *serrata*

Hypericum arnoldianum
 " *densiflorum*
 " *frondosum*

Koelreuteria paniculata
Ligustrum quihoui
Lonicera heckrotti
 " *sempervirens*
Rosa wichuraiana
Securinega suffruticosa
Stewartia ovata
Symphoricarpos chenaulti

Symphoricarpos orbiculatus
Tamarix odessana
“ *pentandra*
Yucca filamentosa

Late July

Acanthopanax senticosus
Abelia schumannii
Ampelopsis brevipedunculata
Aralia spinosa
Buddleia albiflora
Calluna vulgaris and varieties
Cephalanthus occidentalis
Clethra acuminata
“ *alnifolia*
“ *barbinervis*
Hypericum prolificum
Kalopanax pictus
Lespedeza bicolor
Nandina domestica
Oxydendrum arboreum
Sorbaria arborea

August

Abelia grandiflora
Aralia chinensis
“ *elata*

Buddleia davidi varieties
Caryopteris incana
Clematis virginiana
Clematis vitalba
Clerodendron trichotomum
Hibiscus syriacus varieties
Hydrangea macrophylla
“ *paniculata*
“ “ *grandiflora*
Hypericum dawsonianum
Lagerstroemia indica
Lespedeza cyrtobotrya
Polygonum auberti
Rhus copallina
Sophora japonica
Vitex agnus-castus
“ *negundo incisa*

September

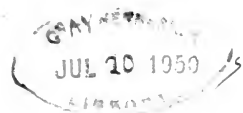
Baccharis halimifolia
Clematis paniculata
Elsholtzia stauntoni
Franklinia alatamaha

October

Hamamelis virginiana
Lespedeza japonica

DONALD WYMAN

ARNOLDIA



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ROOTSTOCKS FOR LILACS

THE varieties of common lilacs are generally propagated by cuttings or by budding or grafting on privet or lilac rootstocks. There are certain disadvantages in all of these methods of propagation. Propagation by hardwood cuttings is usually unproductive. Softwood cuttings are more successful, but these must be made during the busy season. In either case the resulting plants grow slowly and ordinarily require three years to attain a height of two feet.

Privet rootstocks are used extensively in the propagation of common lilacs, because budding or grafting can be done during the slack season and a marketable plant can be produced in two years. If, however, the privet rootstock is retained, the lilac will suffer from "graft blight." Twenty years ago Chester (1), working at the Arnold Arboretum, observed that lilac grafted on privet made good growth for several years. Symptoms of graft blight were evident, but had little effect until the plants were three to five years old. At that time the leaves became small, brittle, and chlorotic, and plant growth was retarded. If, however, the privet rootstock is used only as a temporary nurse root, the graft blight does not persist and a healthy plant is produced. By planting the grafts deep the scions of most lilac varieties will strike root and replace the privet rootstock. But too often the deep planting is delayed or is inadequate, so that the privet root survives and injures the lilac in later years.

Both the *vulgaris* lilac and *villosa* lilac have been used as rootstocks for the common hybrid lilacs. Shoots from the *villosa* rootstocks can be recognized and removed, but sucker growth from *vulgaris* rootstocks often cannot be readily differentiated from the grafted variety, and the rootstock growth may replace the grafted scion.

There are many advantages in growing the common lilacs on their own roots either by cuttings or by use of a nurse rootstock. There is no danger of graft blight, no possibility of the rootstock replacing the grafted variety, and the

suckering from the own rooted lilac is the best insurance against the ravages of the lilac borer. On the other hand, the profuse development of suckers from the root produces so many stems that regular pruning is necessary to promote vigorous growth and flowering of the main stems.

Several methods of propagation have been developed recently which should be of considerable value in the propagation of the common lilac. The Kerr method of grafting should permit the use of privet and other rootstocks with much less danger of the persistence of the nurse root. This method takes advantage of hormone polarity. The piece root is grafted upside down so that the root promoting hormone is accumulated at the graft union and stimulates rooting of the scion and suppresses growth of the nurse root. This method has been used in the propagation of Arnold Giant forsythia, a variety which is hard to root from cuttings, by Richard Fillmore (2) at the Arnold Arboretum.

Another method of lilac propagation which appears to be promising is the use of the tree lilac as a rootstock or nurse root for the common lilac. The tree lilac, *Syringa amurensis japonica* (Maxim.) in Japan grows to be a tree 30 feet tall. Although it is in the subgenus *Ligustrina* it is compatible in grafting with most species and varieties of the *Eusyringa*. The seedlings require two season's growth in New England before they are large enough to bud or graft. The tree lilac seedlings have been budded and grafted with various *vulgaris* varieties, with *villosa* hybrids, and with hybrids between *vulgaris* and *laciniata*. All have made good growth. The average growth of common lilacs budded on tree lilac has been about 18 inches the first year, although occasionally one-year whips have reached a height of nearly four feet. In most cases the bud union is very good with a subsequent slight overgrowth of the tree lilac rootstock. There have been reports that the tree lilac overgrows the common lilac scion (3), but to date the graft unions appear to be perfect in most cases. The white flowered varieties of common lilac budded on tree lilac have shown some evidence of incompatibility as indicated by the swelling of the stem at the bud union.

The tree lilac does not sucker from the root, and as a result the budded varieties develop a sturdy tree-like growth. The common lilacs on tree lilac rootstocks make rapid growth the first year, but subsequent growth is less rapid. A five year old "Congo" on tree lilac is less than six feet tall, but the plant is very sturdy. The trunk circumference, six inches above the bud union, is five and one-half inches. This specimen first bloomed in the spring of the fifth year, but others have bloomed in the third year. The *villosa* varieties on tree lilac usually bloom the second year.

While it may be too early to predict the ultimate success of the tree lilac as a rootstock the results to date are most promising. If a tree form of common lilac is not desired, the budded plants can be headed back to produce low lateral branches, or the graft union can be planted deep to force rooting from the scion. The use of the tree lilac as a nurse root would avoid all dangers of graft blight.

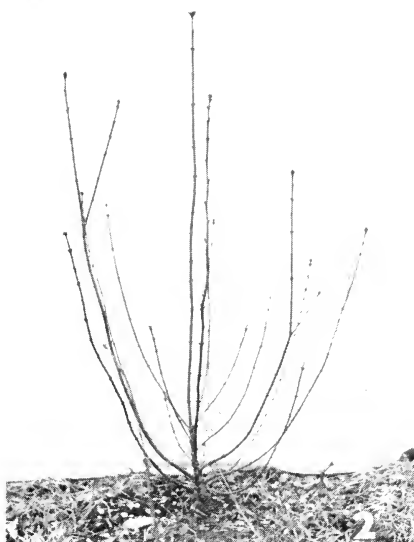
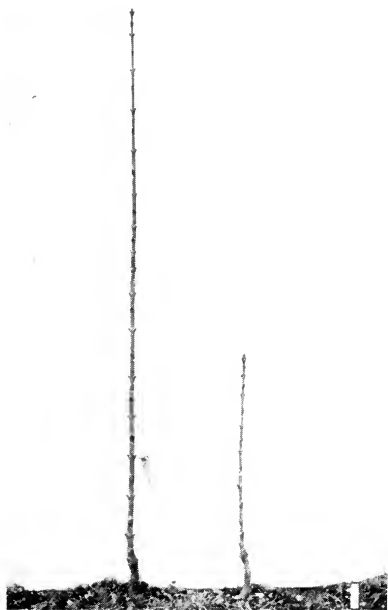


PLATE XIV

Fig. 1. One-year-old whip of *S. vulgaris* "Mrs. Marshall" on *S. amurensis japonica* rootstock. Fig. 2. One year's growth of an F_1 hybrid of *S. laciniata* \times *S. vulgaris* budded on a tree lilac seedling. Many of these *Chinensis* hybrids make more growth in one year on lilac roots than they make in five years on their own roots. Fig. 3. "Congo" budded on tree lilac, flowering at the beginning of the fifth year. Fig. 4. A *Preston* hybrid lilac budded on tree lilac bloomed the second year and flowered fully the third year.

The use of tree lilac rootstocks appears to merit trial by commercial propagators. The Arnold Arboretum has a limited amount of seed for distribution to propagators who may be interested in testing the tree lilac as a rootstock for common lilacs.

KARL SAX

REFERENCES

1. Chester, K. S. Graft-blight; a disease of lilac related to the employment of certain understocks in propagation. *Jour. Arn. Arb.* 12: 79-146. 1931.
2. Fillmore, R. H. Upside Down Grafting. *Horticulture* 27: 15. 1949.
3. McKelvey, Susan D. *The Lilac*. The Macmillan Co., New York. 1928.

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KILLING WOODY PLANTS WITH CHEMICALS

FOR the past seven years, a considerable number of experiments have been conducted at the Arnold Arboretum with chemical weed killers, much of the work being done at the Arboretum's Case Estates in Weston. In 1944, the first reference was made to what is now popularly termed "2-4-D," and since that time many products have appeared on the market. Some kill "lawn weeds," some "thin carrots," some are supposed to kill poison ivy, and several kill "brush." During this period we have tried several dozen different materials, noted their results, and tried to repeat the experiments with as good or better success. Each year recently, some new and better material has been offered, and been tried here. It may be of interest to ARNOLDIA subscribers to learn a little about these experiments, and especially to learn what the results have been up to the present time.

In the first place, since many "selective" weed killers are available, it is well to understand exactly what our problem is here. Primarily it is one of maintenance, in which we are interested in eliminating poison ivy and the many woody weeds that are continuously appearing in our collections and doing it as thoroughly and economically as possible. Secondly, the hand labor around plants (chiefly in the form of hoeing) which eats so deeply into our maintenance budget, must be reduced in order to keep within budgetary limits. Witch grass is a constant problem, for it grows around specimen shrubs, is difficult to cut except with hand labor, and takes a great deal of nourishment from young plants. Such weeds must be controlled as economically as possible, without injury to any of the specimen plants in the collections. At the present time, most of these things are being done quickly, efficiently and economically, thanks to some of the newer weed killers.

The above objectives should be kept in mind when going through this progress report. So many materials are available today, each one of which may well have

its own specific use, that the following notes should not be used to condemn any individual material for all purposes. A very few materials have proved themselves to be meritorious for our specific purposes, but in order to have the complete picture of what has been done over a seven-year period, this progress report is offered.

Flame Thrower

Experiments were first started in 1943 to eradicate poison ivy with the flame thrower, a kerosene burning torch in which the kerosene vapor (under pressure) is ignited, giving a flame several feet long with a killing temperature of 2000°F. The above-ground parts of this poison ivy were old and woody and it took considerable time on the part of the operator to "burn them off." The operator is frequently in the smoke of the poison ivy, and if he is susceptible, he is often poisoned from the fumes. As a result of this burning, the poison ivy frequently re-sprouted, either the same season or in succeeding seasons, due to the inability of the torch to completely kill the plant below the ground.

In later years, much was claimed for controlling weeds in field crops by "sizz" burners, in which a flame of high heat intensity was quickly passed over annual weeds. If they were tall, it was recommended to go over them in the morning and a second time in the afternoon. This was tried for killing the grass and weeds around the large lilacs in our lilac collection. On May 9, 1947, above-ground parts of the grasses and weeds were killed, but were reappearing from the roots on May 29. They were green again by June 13 and were almost normal grass by July 19. Another time this method was tried around the lilacs, searing the grass foliage twice the same day, but the grass eventually came up from the roots again the same season.

Results: Killing poison ivy and witch grass by use of a flame gun was not satisfactory, nor did it give a complete kill. It was costly in that it took a considerable amount of the operator's time, and dangerous in the case of an operator susceptible to poison ivy poisoning. This type of vigorously growing material is quite different from the small annual weeds in field crops which can be killed by recommended "sizz" burners.

Sodium Arsenite and Sodium Chlorate

Both chemicals were used in 1943 and succeeding years at rates recommended by the manufacturers for the specific weed killers. (Sodium chlorate at the rate of $\frac{3}{4}$ to $1\frac{1}{2}$ lbs. per gallon of water, and sodium arsenite, in a form then commercially available, at 4 gallons to 50 gallons of water.) It was the sodium arsenite that brought home to us the importance of killing annual weeds with sprays, for we found that the materials, plus the labor of applying them to our shrub collection, cost about \$75.00, whereas the labor cost for one hoeing alone (in 1944) was \$355.00. However, sodium arsenite is highly poisonous to the operator and to animal life.

Results: In 1945, these materials were compared with the then-new "2-4-D" for the purpose of killing broad-leaved, herbaceous weeds in grass plots, and "2-4-D" was apparently just as effective. In addition, and as mentioned before, sodium arsenite is poisonous to human beings and animals. Sodium chlorite dries after application, and a serious fire hazard results in areas where it has been used.

Borax

This material has been recommended for killing poison ivy and was used in 1949, being applied at the rate of $\frac{1}{2}$ lb. per square yard. It can be used either in powder form or in solution. It is easier to merely broadcast it in powder form, but it must be washed in by a rain. We applied it on June 2, 1949, and it did not start to kill the poison ivy until July 8, 1949 (due to lack of rain), but by July 28, 1949, after good rains, the poison ivy was completely killed and remained so the succeeding year as well. Incidentally, this was in continuous shade in the woods, one of the most difficult places to eradicate poison ivy. Nevertheless, the use of this material in this fashion would unquestionably be a serious hazard to any tree roots in the area.

Results: A complete kill of poison ivy was obtained. For small areas in home gardens this might prove satisfactory, for it is easy to apply and does not take extra equipment. However, nothing else grew in the soil so treated for a year afterwards. It would be rather difficult and expensive to apply it this way on a large scale—the cost would be nearly five times that of "Ammate."

Kerosene

This cheap oil has been used as a grass killer, especially in edging flower beds. It is effective, kills the lawn grasses completely (the grass is apparently dead an hour after application), is not a fire hazard after drying since it is volatile, but it is inflammable while in use. It costs less than "Ammate" (which kills grass), but considerably more than Dow's "Brush Killer" (which does not kill grass). Soil used after four light applications of kerosene, germinated beets, carrots, lettuce and radishes at once, with no injury whatsoever.

"Ammate"

Sodium sulfamate (popularly termed "Ammate") was in use several years prior to 1945, when we first used "2-4-D." It was at first recommended only for poison ivy eradication. Many experiments have been conducted with this material at the Arnold Arboretum, but we will mention just those during 1949 and 1950, when "Ammate" was being compared with Dow's "Brush Killer." Applied on June 2, 1949 (at the rate of 1 lb. per gallon of water), to poison ivy growing in continual shade, the plants were apparently dead by June 16, 1949, and no shoots came up from this spot in 1950. During some of our experiments with grasses, it was found that "Ammate" did not always kill grass completely, but

in one experiment with witch grass 18" tall, it completely killed the grass in four days, and none sprouted the rest of the season. Mr. R. G. Williams, Superintendent of the Arboretum, noticing that the material does not adhere well to waxy-leaved weeds, has been using O. E. Link's "W.A." as a wetting agent, with apparently much better results.

Blueberries and young peaches have easily been killed merely by the application of this "Ammate" spray to the soil about their roots, and not to their foliage. The time of application to plants in general seems to make little difference, since witch grass has been completely killed (at Rhode Island State College) when applications have been made from July 1 to October 1.

Applied on June 9, 1950, to the young suckers around lilacs (and also in 1947), the suckers hit by the spray were killed, but the untouched parts of the plant were not affected in any way, either then or later. Sprayed against the trunk of a large lilac, no injury was observed to any portions of the plant above the point of application.

Results: Sodium sulfamate has proved to be an efficient killer of woody weeds. There is no fire or explosion hazard in its use. Most important, we have found no "drift" injury to other plants. So often, with "2-4-D" and similar materials, regardless of how careful the operators are, there is a drift to nearby plants that results in severe injury. "Ammate" does not kill members of the genus *Rubus* in the shade more than about 75%, and *Fraxinus* only about 50 to 75%. We have used it to kill standing trees, by notching around the trunk and thoroughly soaking the cut surfaces with a solution of 4 lbs. of "Ammate" in 1 gallon of water. Smaller tree stumps (6") have been notched with a "V" cut in the stump after the tree was cut down, and a tablespoon of "Ammate" crystals put in to prevent the stump from re-sprouting. However, "Ammate" is corrosive to pump parts, causing abnormal rusting of iron or steel and the electrolytic reaction on brass which makes it break easily.

Some of the plants (none over 8' in height) we have killed with one application of "Ammate" spray prior to July 15 are:

Aronia arbutifolia	Quercus rubra
Berberis vulgaris	Rhus glabra
Castanea dentata	“ typhina
Pinus strobus	Sambucus canadensis
Prunus serotina	Vaccinium angustifolium
Prunus virginiana	“ corymbosum
Quercus alba	Vitis labrusca

In a woodland of cut white and red oaks with 3 to 12" stumps, most of which had 3' suckers by June 5, 1950, we sprayed once with "Ammate" to thoroughly cover these suckers, almost completely killing them. **Caution:** See note page 70.

Sovasol #5

Also known as "Stoddard's Solvent #5," "Mineral Spirits," and "Sun Spirits," "Sovasol" is a naphtha-type petroleum product used in industry as a paint thinner, a solvent, and for dry cleaning clothes. It is inflammable but not explosive, and has been sprayed for several years on carrot seedlings to thin them as well as to kill the weeds among the seedlings. It evaporates rapidly, is relatively non-toxic to human beings, and will not plug or corrode spraying equipment, although rubber and leather washers as well as pump fixtures will disintegrate after a period of use with this material.

As a selective weed killer for carrots it has been used considerably, and is recommended widely for killing herbaceous weed seedlings. It has been shown that plants like *Juniperus virginiana*, spruce and hemlock are highly resistant to injury from it (if small amounts reach the foliage), but that *Taxus* is very susceptible to injury from this material.

It has been used at the Arnold Arboretum regularly for three years now, to kill small herbaceous weed plants in the shrub collection. As a brush killer, it was tried on June 9, 1950, on poison ivy in sun and shade, *Rubus*, *Sambucus canadensis*, *Acer rubrum* and *Prunus virginiana*.

Results: When applied at full strength on the above plants, foliage was killed within an hour, but most of the plants were growing remarkably well again by July 1, 1950. Even ragweed and morning-glory started growth after treatment. The spray did not kill poison ivy, some of which still grew well two weeks after being treated. Since "Sovasol" is highly volatile, the soil hit by the spray was not affected, and seeds of lettuce, beets, and radishes germinated and grew in the upper half inch of loam a few days after application. Applied to witch grass 18" tall on June 9, 1950, the tops were killed within an hour, but the grass was growing vigorously again from the roots by July 9, 1950. Applied to lilac suckers around a huge plant, it killed the suckers to which it was applied and was not absorbed in sufficient quantity by the larger stems to cause injury to them. Sprayed on the trunk of a lilac, it did not injure the foliage above the spot of application.

Considering that it is as costly as sodium sulfamate (on a sprayed area basis), it is not nearly as good a killer of woody plant weeds or witch grass. The perennial grasses and woody weeds are killed to the ground only. Small herbaceous weeds are killed quickly, and for this purpose it has merit.

"2-4-D"

(2-4-dichlorophenoxyacetic acid)

We have been experimenting with this material since the spring of 1945, only a few months after its plant-killing properties became known. Erratic results have been obtained from the first, especially when the material was used in the shade. When sprayed on suckers (about 3' tall) of a large lilac bush, the suckers

in full sunlight were killed—those in the shade were not. Sometimes it proved effective on poison ivy, yet frequently, when applied in the shade, it was not thoroughly effective.

It has been produced in several forms, and widely advertised under various trade names. We have used Dow Chemical Company's "Esteron 44" (which is the isopropyl ester of "2-4-D") with some success.

Results: Because of superior results with Dow's "Brush Killer," "Ammate" and "T.C.A.," no detailed experiments with "2-4-D" will be discussed. Both the salts and esters have been tried. As a killer of broad-leaved, herbaceous weeds in the lawn, "2-4-D" in one or more of its several forms may have its place, but in view of many experiments which we have carried out, it is not (alone) a dependable killer of miscellaneous woody plants. Among poison ivy plots receiving five different treatments in 1949, only those treated with "2-4-D" produced new growth eight weeks after application. "2-4-D" was applied at the direction of the manufacturer. Time and again it has produced very poor kills on *Fraxinus americana*, *Acer rubrum*, *Rubus* species and poison ivy, especially in the shade.

In one experiment it was applied to weeds along plant rows in our Weston nurseries. Broad-leaved weeds were killed (they were only a few inches tall), but of course the witch grass and the crab grass were not. At the end of the summer, plots treated with kerosene were devoid of all weeds and grass, while those sprayed at the same time with "2-4-D" had no broad-leaved weeds, but were thickly covered with crab grass 2' tall.

Dow's "Brush Killer"

(Being a mixture, half and half, of the isopropyl ester of "2-4-D" and the isopropyl ester of 2-4-5 trichlorophenoxyacetic acid)

In the spring of 1947, chemists of the Dow Chemical Company were experimenting with "2-4-5-T," and found it gave a better kill for certain specific weeds like blackberry, raspberry and dewberry, than did "2-4-D." Shortly after, it was found that a mixture of the two were even more effective, and in 1949 we were experimenting with this combination. The esters of these acids seem to be more soluble in the wax of the leaf epidermis than are the salts, possibly one of the reasons why Dow's "Brush Killer" is more effective, especially in rainy weather.

As a dormant spray, 2 pints of "Brush Killer" were mixed in 10 gallons of kerosene and sprayed on brush March 25, 1949. The brush was not over 4' tall, but it included poison ivy, ash, red and sugar maple, blackberry, raspberry, dewberry and gray birch. All this brush failed to grow in the spring of 1949, and it was apparently completely killed. Brush in ground immediately adjacent, and not sprayed, grew vigorously.

In extensive spraying operations with "Brush Killer" during 1950 at our Case

Estates in Weston, many plants were killed, most of them apparently within two days after spraying. Poison ivy was entirely killed where it grew in the shade, with one spray applied June 2, 1949, and in another plot, on June 2, 1950. Even *Polygonum cuspidatum*, a vicious weed once it is established, was killed when sprayed June 9, 1950. Other woody plants killed in the 1950 experiments were American ash, red and white oak, red maple, American linden, gray and paper birch, black cherry, willow, smooth and staghorn sumac, elderberry, meadow-sweet, Virginia rose and brambles. Of these, the only plant in our experiments which showed much resistance was the American ash.

Results: Dow's "Brush Killer," applied at recommended strengths, is an effective woody plant killer. It has killed most of the actively-growing brush on which we have sprayed it—brush seldom over 6-8' tall, and usually much smaller. When applied on a sunny day, the usual affect is a drooping of the leaves a few hours after application. It must be particularly noted that all applications were made on suckers that were growing vigorously. The one serious danger in using "Brush Killer" results from "drift," for, if applied on a windy day, the spray can be easily blown some distance and can severely injure plants. In fact, the odor of "Brush Killer" is noticeable in the vicinity days or even weeks after application, and I am inclined to believe that the very small amount in the atmosphere (as evidenced by that odor), can injure overly susceptible plants.

Because of this feature, care must be taken when using it near valuable plants, especially if it is known in advance that they are susceptible.

A list of plants (not over 6-8' tall) that were killed with Dow's "Brush Killer" follows:

Acer negundo	Hicoria ovata
“ rubrum	Malus sdlg. of many species
“ saccharum	Parthenocissus quinquefolia
Amelanchier canadensis	Polygonum cuspidatum
Aronia arbutifolia	Populus tremuloides
Berberis vulgaris	Prunus serotina
Betula papyrifera	“ virginiana
“ populifolia	Quercus alba
Bocconia cordata	“ rubra
Carya ovata	Rhus - several species
Castanea dentata	Robinia hispida
Cornus florida	“ pseudoacacia
“ racemosa	Rosa virginiana
Crataegus - many species	Rubus species
Fagus grandifolia	Salix species
Fraxinus americana (but some resist- ant)	Sambucus canadensis
	Sassafras albidum

Solanum dulcamara
Spiraea tomentosa
Tilia americana
Ulmus americana

Vaccinium angustifolium laevifolium
" *corymbosum*
Vitis species

"T. C. A."

The sodium salt of trichloroacetic acid (popularly termed "T. C. A." in the trade) is much easier and safer to use than the acid itself. It was first suggested a few years ago as a weed killer, and has been available for this purpose since 1949. First experiments in the Arnold Arboretum were undertaken in 1949 when 60% "T. C. A." was used at the rate of 1 lb. per gallon of water and sprinkled on weeds and witch grass in several places at the Case Estates in Weston, as well as between the vines along the Arborway wall in the Arboretum. Applications were made in some areas July 1, 1949, and in others September 1, 1949. In all instances the grass (witch grass, Kentucky Blue, Red top, Orchard grass and Timothy) was brown and dead the next day, and no perennial grasses have come up in these treated plots for a year. A few annual weeds have grown, but they undoubtedly have seeded-in since the original spraying was done.

Unlike the chlorates or arsenites, there is no long-term soil sterilization, since soil can be taken sixty to ninety days after "T. C. A." is applied, and seeds of vegetables can be quickly and normally germinated.

On May 5, 1950, 70% "T. C. A." was applied (1 lb. dissolved in 1 gallon of water) to witch grass growing beneath overhanging branches of *Prunus maritima* plants about 5' tall. The grass was completely killed in three days. No damage to the plants was noted until June 13, when some of the leaves began to turn color, dry up and fall off. One or two bushes were apparently killed. Several sent out a new set of leaves by July 7, 1950. Absolutely no "drift" hit the branches. The same treatment was given witch grass under *Malus sikkimensis* plants about 6' tall. Here again the grass was killed at once and although the trees showed no apparent injury they failed to grow any more for the rest of the season.

"T. C. A." (70%, 1 lb. per gallon of water) sprayed on lilac suckers 3' tall, quickly killed the suckers. Within two weeks the tops of the original 12' plants were dying. No "drift" reached them. Apparently the material was translocated from the injured suckers to the tops of the plants. The material also was sprayed on lilac trunks, wetting the bark, but no injury to the tops occurred within three months' time.

Rubus was not entirely killed in the shade (only about 95% kill was obtained), but in the sun nearly perfect kill was obtained.

Results: Nearly complete kill on everything in the shade, and excellent kill on all woody weeds in the sun was obtained by using "T.C.A." in this strength. Others have stated that the sterilizing effects in the soil last only sixty to ninety

days, depending upon the type of soil and the amount of moisture in it. Because of its action on *Prunus maritima*, when the material did not touch the plant foliage, and on lilacs, when it was apparently sprayed only on the foliage of suckers and then translocated to the tops of 12' stalks at least 6' away from the point of application, it would seem that this is a dangerous material to use in the vicinity of valuable woody plants. It is the most expensive of the materials here discussed (figured on an area-of-application basis). It is caustic to the skin if left on for a period, but is not seriously poisonous.

Hop Mulch As A Weed Preventative

Spent hops have been used in the Arnold Arboretum since 1946. This is the best material we have found for suppressing weeds around plants, while at the same time it acts as a mulch that is resistant to fire. Many mulches burn readily and are impractical in a public place such as the Arboretum where the danger of fire among valuable plants is a very real one. Applied as a 4 to 6" mulch around plants, hops are merely stirred every month or so with a fork, if weeds grow through them. There have been examples in the Arboretum where this was not necessary until the second year after application. They are very acid, and probably should not be applied to lime-loving plants. We apply them to plants directly as they come from the brewery. The only precaution taken is to keep them 6" away from the trunks or bark of plant shoots, for, on hot days, the temperature of these wet hops can easily be raised to such a high point that they may kill any living plant tissue with which they come in contact.

SUMMARY

DuPont's "Ammate" has proved successful (used at the rate of one pound per gallon of water) for killing brush, broad-leaved herbaceous weeds, grass and poison ivy.

Dow's "Brush Killer" (half "2-4-D" and half "2-4-5-T") has proved effective in killing brush under 6 to 8' in height in one treatment, when applied while the plants are still in active growth at the rate of three quarts per one hundred gallons of water.

Dow's "T. C. A." has proved effective in killing brush, poison ivy and grass in one application.

"Ammate" does kill grass as does "T. C. A." "Brush Killer" does not. The latter is only one half as expensive (estimated on area-covered basis) as "Ammate," which in turn is only one half as expensive as "T. C. A." can be slightly dangerous and can cause some skin irritation to the operator if it gets on the hands, face, or in the eyes. The mist or drift of "Brush Killer" can cause injury to other plants some distance away, unless properly applied on a quiet day.

Poison ivy in sun or shade can be killed by all three materials if applied during the active growing season. Sometimes a second application is necessary late

in the summer. We have completely eradicated large areas in this way, but from an economic point of view, "Brush Killer" is cheapest.

"Sovasol" (costing about the same as "Ammate") is excellent for spraying on grass and young herbaceous weeds (a few inches high), quickly killing them to the ground within a few hours. Small weeds are entirely killed — grass is killed only to the ground. Brush is slightly injured and very poor killing results have been obtained on poison ivy. Because of "Sovasol's" rapid action, the work of the operator can be quickly checked. This material is highly volatile, and the drift is not seriously troublesome to plants in most cases.

"T. C. A." can be highly destructive to plants, especially when merely sprayed on the grass under spreading branches. It is apparently quickly absorbed by the roots of plants and may damage tall lilacs, for instance, when it has only been sprayed on a few surrounding suckers. "Brush Killer" and "Sovasol" are not as destructive when used in this manner, although there is always the danger of injuring valuable plants when such spraying is done near them.

Present indications are that the transportation of "2-4-D" (and also "2-4-5-T") in plants is similar to that of the translocation of carbohydrates. When plants are more difficult to kill in the shade than in the sun it would seem that in the sun there is greater photosynthetic activity, hence a greater translocation of carbohydrates. In the shade, there is less photosynthetic activity and less translocation of carbohydrates, hence less movement of "2-4-D," resulting in less effective killing. In hot, dry spells during the summer months, the translocation of carbohydrates toward the storage organs may be at a minimum in certain plants, hence killing plants with "2-4-D" at this time has not been as complete as it has been earlier, when the translocation of carbohydrates from the leaves to the roots was more pronounced.

To summarize, Dow's "Brush Killer" is the cheapest material for eradicating most types of brush (under 6 to 8' tall) when applied before the end of the growing season, or about mid-June. However, there is always the danger of drift injury to other plants. "Brush Killer" will not kill grass.

DuPont's "Ammate" will also kill brush and poison ivy as well as witch grass. There is little drift injury, action is often quicker than with "Brush Killer," but the cost is twice as much.*

Dow's "T. C. A." is also an effective killer of brush, poison ivy and witch grass, is slightly dangerous to the operator and costs (at present) four times as much as "Brush Killer." It should be kept away from the roots of valuable specimens.

Other materials which we have used for eradicating brush and poison ivy (including sodium arsenite, sodium chlorate, "2-4-D" used alone, borax, kerosene, burning, etc.) are not as practical nor as effective as the above materials.

*Note: One serious effect of "Ammate" has just become evident in our 1950 experiments. The foliage of poison ivy was sprayed under pine trees 6" in diam-

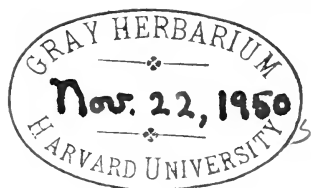
eter, during early summer. The soil was not soaked — merely enough spray was applied to moisten the foliage. Within three weeks all of the foliage on several 35' pine trees was dead. As soon as this was noted, the experiment was repeated, with the same result. The destructive effect on white pines, at least, during a drought period, is serious. Hence, "Ammate" should never be used under pine trees.

DONALD WYMAN

Note: At the national convention of the American Association of Nurserymen, held this summer in Washington, D.C., Dr. Donald Wyman was presented with the first Norman Jay Colman Award. This commemorates the name of a former prominent nurseryman who was also Secretary of Agriculture (1889) and is to be given annually to stimulate "horticultural progress through research." The committee selecting the winner was composed of five Experiment Station Directors and was awarded for the research work in ornamental horticulture which went into the preparation of the book *SHRUBS AND VINES FOR AMERICAN GARDENS*, published in 1949.



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DWARF TREES

THE growing interest in horticulture has led to a greater demand for dwarf trees which can be grown in a limited space. Dwarf fruit trees have long been grown in the home gardens of Western Europe, and dwarf ornamental trees are a characteristic feature of Japanese gardens. Dwarf trees have many advantages. For ornamental purposes they are well adapted to the small garden where space is not adequate for standard sized trees. For the home orchard dwarf trees require less space, they are easier to spray and prune, and several varieties will provide enough fruit throughout the season for the average family.

There are many ways of producing dwarf trees. Trees grown in pots can be restricted in root development and with some judicious pruning can be restricted to a few feet in height even when they are more than a hundred years old. An excellent collection of these Japanese dwarf trees was given to the Arnold Arboretum by the late Mrs. Larz Anderson, and are on display in a lath house near the Arboretum greenhouses.

Occasionally dwarf trees are obtained by mutation or by genetic segregation. The dwarf conifers are good examples of "sports" derived from standard trees by mutation. An excellent collection of these dwarf conifers may be seen in the Arboretum collection. Such mutants can be perpetuated by grafts or cuttings. Species hybrids often produce dwarf segregates. One such segregate is a dwarf forsythia with leaves only an inch long. Among our apple hybrids there is one tree which at the age of ten years is less than five feet tall, with a compact, almost globular form.

The dwarfing of fruit trees by grafting on appropriate rootstocks has long been known in Europe. Graves (1), in a recent review of the art of grafting, has shown that the techniques were well known and practiced in the sixteenth century. Bradley (2), in 1726, not only refers to dwarfing stocks for apples and pears, but describes upside down grafts. Horticulturists in England have re-

cently standardized the clonal stocks for apples, and these are referred to as "Malling" stocks. The most dwarfing rootstock is "Malling #9," but the root system is weak and the grafted tree must be staked. "Malling #7" makes a better root system, but is only semi-dwarfing.

The Malling rootstocks are propagated by layering—an expensive process—because most apple varieties do not come true from seed. We have found, however, that many of the Asiatic species of apple do breed true from seed, and we are testing these as rootstocks for both ornamental crabs and commercial varieties. *Malus sikkimensis* seems to be a good semi-dwarfing rootstock. "McIntosh" budded on *M. sikkimensis* seedlings have produced semi-dwarf spreading trees. A 10-year "McIntosh" is shown in Figure 1, which bore more than 250 apples last summer. The rootstock causes the low spreading growth habit. The graft union is excellent with some overgrowth of the rootstock characteristic of dwarfing rootstocks (Figure 2). *Malus florentina*, a species from north Italy, is too dwarfing and a three-year old "McIntosh" budded on this rootstock is only about 2 feet tall. The Sargent Crab seems to be a good dwarfing stock, but different varieties vary greatly in growth when budded on *Malus sargentii*.

Another method of modifying the growth of apple trees is by upside down budding or grafting. More than 25 years ago I budded one-year apple whips, placing the buds where the permanent branches were wanted, but the buds were inserted upside down. This work has been repeated and a photograph of such a tree is shown in Figure 3. The buds start growing towards the ground, and the branches gradually grow upward to form a spreading tree with unbreakable crotches. In pears such flattened trees bear earlier. In parts of Europe and California the branches of young pear trees are often tied down in a nearly horizontal position in order to flatten the tree and make it bear earlier. A "Clapp's Favorite" pear on the Bussey grounds has been treated in this manner with very satisfactory results.

Another process is based upon the transfer of plant hormones. The plant hormones produced by the leaves and growing points pass down the phloem of the bark and stimulate root growth. The passage of the hormone in the phloem is in only one direction. If a complete ring of bark is removed from the trunk of the young tree and turned upside down, the plant hormone is checked and a swelling occurs at the point of bark reversal. As a result the hormone does not get to the roots in normal amounts and growth of the tree is retarded. The tree shown in Figure 4 had a section of bark inverted three years ago.

Bradley, in 1726, described a method of grafting which we have repeated with some modification. The tops of two seedling pears growing about 18 inches apart in the nursery row were brought together. A graft was made so that the stems formed an arch. According to Bradley, if the roots of one of the two seedlings are dug up and the seedling staked upright so that it stands inverted on the stem of the other seedling, the roots in the air will form leaves and flowers. We do

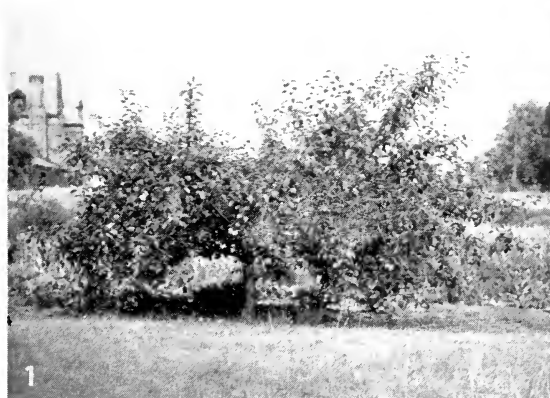


PLATE XV

not expect such results, but we have inserted a "Clapp's Favorite" bud upside down a few inches beyond the graft. Next spring the seedlings will be cut off just below the inserted bud. As a result we shall have a normal pear seedling with an upside down section of the second seedling, and on top of this the bud which is to form the new tree. The inverted stem section should exert a dwarfing effect. In the upside down bark and stem grafts it is possible that the new cells may eventually become reoriented to provide normal polarity. In such case the dwarfing effect would be temporary.

Many species of apples, pears, hawthorns, and other Pomoideae have been intergrafted to find dwarfing stocks. A promising dwarfing stock for pears is *Cotoneaster multiflora*, although not all cultivated pears grow well on *Cotoneaster*.

Quince rootstocks of specific clonal lines are commonly used for dwarfing pears, but since all pear varieties will not grow on quince, double working is often necessary, as is the case with *Cotoneaster*. The *Cotoneaster* root system makes it difficult to transplant the grafted pear, so we now bud *Cotoneaster* on either wild pear or on hawthorn and double work with cultivated pear. Thus we have a seedling pear or hawthorn root, an intermediate stem of *Cotoneaster*, and a pear top. The intermediate stem piece acts as a dwarfing stock.

One of the most interesting combinations is *Aronia arbutifolia* budded on hawthorn rootstock. There is considerable overgrowth of the *Crataegus pedicellata* rootstock, but the *Aronia* top is healthy and fruited abundantly in its third year. The tree form is much more attractive than the usual bush type (Figure 8).

Graft combinations of various *Prunus* species have shown some interesting results. Peaches and plums budded on *Prunus tomentosa* seedling rootstocks produce dwarfed trees which bear early. All varieties of peaches and plums do not make compatible unions with the Nanking Cherry rootstock. Most peaches budded on *P. tomentosa* produce trees about two to nearly three feet tall the first year. The second year most of them flower and occasionally fruits are produced. A two-year old tree of "Jerseyland" peach bore eleven full-sized peaches the second year after budding, and the peaches were ripe before August 1 in 1949 (Figure 5). This summer a four-year old "Valencia" peach on *P. tomentosa* stock bore 84 peaches on a tree about six feet tall.

Prunus tomentosa is also a good rootstock for plums and a three-year old "Stanley" plum tree flowered heavily and bore a few fruits this summer, although the tree was little more than three feet tall (Figure 6). *Prunus triloba multiplex* budded on *P. tomentosa* produced a tree growth habit, although both stock and scion species commonly grow as a spreading bush. The tree form is most attractive and the plant bloomed profusely the second year. A picture of this graft at the age of three years is shown in Figure 7.

Beach plums have also been grown on *P. tomentosa*. Seedlings or cuttings of beach plums are often difficult to transplant and it is hoped that by budding on the Nanking Cherry, with its more fibrous root system, the peach plum can be



PLATE XVI

transplanted more readily. There is some dwarfing effect of the *P. tomentosa* rootstock, but the beach plums are still too young to be sure of ultimate success.

Peaches and plums are dwarfed even more when budded on *Prunus glandulosa*, but this rootstock suckers badly from the root and the suckers have to be pruned back for several years. In spite of this difficulty, *P. glandulosa* may prove to be a better rootstock than *P. tomentosa* because of better compatibility with more varieties of peach and plum, and a somewhat greater dwarfing effect.

It is hoped that eventually we shall be able to produce dwarf apples, pears, peaches and plums, as well as dwarf ornamental trees and shrubs, on seedling rootstocks which will induce the desired degree of dwarfing. Most people prefer trees which are small and can be cared for by the home gardener. Although our work with seedling dwarfing stocks is still in the early stages of development, many horticulturists may be interested in the project, and all are invited to visit our test plots at the Bussey Institution adjacent to the Arnold Arboretum.

KARL SAX

1. Graves, George. Double working, the art of setting graft upon graft. Nat. Hort. Mag. 29: 118-127. 1950.
2. Bradley, R. A general treatise of husbandry and gardening. London 1726.

DESCRIPTION OF PHOTOGRAPHS

- Fig. 1. "McIntosh" budded on *M. sikkimensis*, 10 years old. This degree of dwarfing should be of value to the commercial grower.
- Fig. 2. Graft union of above tree. Note overgrowth of rootstock.
- Fig. 3. Two year old "Golden Delicious" with branches developing from buds inserted upside down the previous summer.
- Fig. 4. An ornamental crab apple which has been dwarfed by inverting a ring of bark near the base of the trunk.
- Fig. 5. Two year old "Jerseyland" peach on *P. tomentosa* bearing 11 fruits on tree 3 feet tall.
- Fig. 6. Three year old "Stanley" plum on *P. tomentosa*.
- Fig. 7. *Prunus triloba multipler* on *Prunus tomentosa*. Three years old.
- Fig. 8. *Aronia arbutifolia* on *Crataegus pedicellata*. This little tree was covered with fruit at the age of four years. Note great overgrowth of hawthorn rootstock.

All of these photographs were taken by Mr. Heman Howard, staff photographer at the Arnold Arboretum.



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FRUITING HABITS OF CERTAIN ORNAMENTAL PLANTS

THERE are many species of plants with flowers dioecious, their flowering habits unnoticed except in botanical texts. However, some of these plants are valued highly for their very ornamental fruit. *Taxus*, *Celastrus*, *Lindera*, *Nemopanthes*, *Ilex*, *Ailanthus*, *Phellodendron* and *Morus* are only a few of the genera included in a lengthy list. Experiments were started in 1946 with some of these in an attempt to determine which were parthenocarpic, whether wind or insect fertilization is necessary and the most difficult of all — how far removed a pollen source can be and still effectively pollinize pistillate plants. Theoretically this might be three miles or less — the distance of the normal flight of bees. Answers for all these questions on all species in the trials are not available and will not be for some time.

It has been known for some time that the bright red fleshy fruits of *Ilex cornuta* will develop without fertilization. Numerous reports have been made about *Ilex opaca*, to the effect that certain trees have been known to bear fruit "without a male plant for at least a mile" from the pistillate plant in question. Zimmerman and Hitchcock of the Boyce Thompson Institute have reported that they have investigated many such plants and examined thousands of other plants, and failed to find a single plant with perfect flowers. I have been interested in other species, merely to ascertain whether they would produce ornamental fruits without fertilization, and to determine whether the pollen of certain species was carried chiefly by wind or insects.

Bagging experiments were started in 1947, and repeated in 1948 and 1949. Paper bags of the type used in corn pollination studies were used, and in 1949 many fine mesh cloth bags were tied on the branches of certain species to determine which might be wind pollinated as well as insect pollinated. At least a dozen bags were used on each plant, and usually the pistillate plant was growing in the near vicinity (less than twenty feet) from the male plant. The exact time

of bloom of all these plants was in the records at the Arnold Arboretum, so that the time of placing the bags before the flowers opened was not difficult.

In many cases it was found, as would be expected, that the fruits of the plants in the paper bags started to form but dropped off prematurely. In the case of *Baccharis halimifolia* (which is of ornamental value because of the prominent thistle-like pistils of the pistillate plant) it made no difference whether or not the flowers received pollen as far as the initial appearance of the pistillate flowers was concerned, but the pistils of the fertilized flowers remained on the plant and were conspicuous for about twelve weeks longer than those not fertilized. In this case at least, the pistillate plant is the only one worth propagating as an ornamental for a short-time display (about six weeks) but for a longer display, fertilization is necessary.

In the case of *Cotinus coggygria*, which is ornamental because of the wavy pedicels of the sterile flowers, of which there are many on certain clones, it made no difference whether the flowers received pollen or not. Hence staminate plants in this species are of little ornamental use.

The following plants were bagged with paper and cloth bags with the following results:

FRUIT DEVELOPMENT

<i>Name of Plant</i>	<i>Time of bagging</i>	<i>Paper bags</i>	<i>Fine Mesh Cloth Bags (40 openings per inch)</i>
<i>Ailanthus altissima</i>	5/25/49	none	normal
<i>Celastrus orbiculata</i>	6/1/47	none	normal
	6/4/48	"	"
	6/5/49	"	"
<i>Celastrus scandens</i>	6/1/47	none	normal
	6/4/48	"	"
	6/5/49	"	"
<i>Chionanthus retusa</i> *	6/4/47	normal	normal
	5/6/49	"	"
<i>Chionanthus virginica</i>	6/5/47	none	not done
<i>Ilex laevigata</i>	6/1/47	normal	normal
	6/5/48	"	"
<i>Ilex verticillata</i>	6/4/47	none	not done
	6/5/48	"	"
	5/25/49	"	"

<i>Ilex yunnanensis</i>	6/4/47 6/1/49	none “	none ‡ “
<i>Lindera benzoin</i>	3/28/49	none	not done
<i>Morus alba</i>	5/1/47	normal	not done
<i>Morus tatarica</i>	5/2/48	normal	not done
<i>Nemopanthus mucronata</i>	4/10/47 4/15/49	none “	normal “
<i>Phellodendron amurense</i>	5/15/47 5/16/49	none “	normal “
<i>Phellodendron lavalleyi</i>	5/6/49	none	normal
<i>Phellodendron sachalinense</i>	5/16/49	none	normal
<i>Taxus cuspidata</i>	3/20/47 3/15/48 3/24/49	none “ “	normal “ “

* These flowers appeared to be polygamodioecious.

‡ Apparently no source of suitable pollen close by since this plant has not borne fruits for years.

The interesting points shown above are that in the clones used of *Chionanthus retusa*, *Morus alba*, *Morus tatarica*, and *Ilex laevigata*, staminate plants and outside pollen are not necessary for the production of ornamental bright-colored, fleshy fruits — a rather important observation from the standpoint of the gardener as well as the commercial grower. As might be expected, all of these plants can be wind pollinated.

“Fruitone,” a trade-marked hormone powder including naphthalene acetic acid was dusted on the open flowers of some of the bagged plants, namely *Ilex verticillata*, *Ilex yunnanensis*, *Celastrus orbiculata* and *C. scandens*, and *Ilex montana*.

In only one case, that of *Ilex montana*, was it successful as a producer of fruits as noted in the table below.

Bag	No. of flowers treated with fruitone	No. of fruits produced
No. 2	15	11
No. 3	30	11
No. 8	6	3
No. 10	15	4
No. 13	12	7

Ilex yunnanensis has special merit as an ornamental because it has evergreen leaves somewhat the size and shape of *Buxus sempervirens*, and the pistillate plant has bright red fruits about the size of those of *Ilex verticillata*. We finally have been able to obtain a staminate plant from England. It is interesting to note that in 1947 when the pollen of this plant was first used, the flowers so pollinated were the only ones to produce fruits even though the pollen of *I. verticillata*, *I. montana* and *I. opaca* were used. Again in 1949, when branches from the staminate plant were merely laid in the pistillate plant at the time the flowers were in full bloom, the only flowers on the eight-foot pistillate plant to produce fruits were those in the very close vicinity of these pollen-bearing branches.

The peculiarities of *Celastrus* species are being studied more closely. Propagations were started in 1942, from plants of known sex growing in the Arnold Arboretum. These were grown for several years and then planted out in several combinations. Pistillate plants of *C. flagellaris*, *C. orbiculata* and *C. scandens* were planted alone and in combination with male plants of their own and other species. These plants have been checked from year to year in flower and fruit. Some of the interesting things which have developed to date are as follows:

1. *Celastrus orbiculata* cuttings (either male or female) will produce flowers the second year, while those of *C. scandens* will take four to five years to produce flowers, either when grown from cuttings or from seeds.

2. Entirely pistillate plants of *C. orbiculata* (when grown in the same hole with a pollen-bearing plant of the same species) had good crops of fruit in 1946, 1947, 1948, and 1949, showing that this species can be an annual bearer.

3. The application of "Fruitone" powder to the open pistillate flowers of *Celastrus* species enclosed in paper bags did not result in fruits.

4. Bagging unopened pistillate flowers with tightly tied paper bags prevented the development of mature fruits on all three species.

5. Bagging unopened pistillate flowers with cloth bags of very small mesh (40 openings per inch) did not prevent normal fruit formation in either *C. orbiculata* or *C. scandens* in 1949.

6. Bagging unopened pistillate flowers with cloth bags of very small mesh on plants that were at least one hundred feet from the pollen source, did not prevent normal fruit development in *C. orbiculata*.

7. Apparently the pollen of one species is just as effective as another as far as *C. orbiculata* and *C. scandens* are concerned.

8. Both species can be easily budded in August, and one species can be easily budded on the other.

9. A polygamodioecious clone of *C. orbiculata* was found in the Arnold Arboretum, which has produced profuse flowers the third and fourth growing seasons. Flowers are produced on short lateral spurs formed during the previous year's growth as well as on longer shoots made the current year. The fruiting performance of this clone has been erratic. In 1947, sufficient fruits were formed over the entire plant to make it ornamentally acceptable, although in no way was it as profuse as a well grown pistillate plant of the same species growing with a staminate plant.

In 1948, the flower production was profuse, but all the first flowers appearing were staminate. These appeared on the short stubby growths made the previous year. A second crop of flowers was produced a few days later (after the first crop had about fallen) and 10% of these were pistillate flowers but the resulting fruit crop was very poor and not of ornamental value. In 1949, flower and fruit production were profuse, making such vines as ornamentally prominent as pistillate vines fertilized from a nearby pollen source.

Noticing the activity of insects about *Celastrus* flowers when they are open, it is obvious that these are also responsible for a large amount of pollinizing as well as wind currents. The polygamodioecious plants produced poor fruits in 1948, but at present there is no explanation of this. It has been pointed out that *C. orbiculata* can be an annual bearer if the pollen-bearing plant is grown in the same hole. Since the *Celastrus* species are both wind and insect pollinized, weather conditions need not necessarily effect fruiting, providing, of course, staminate and pistillate flowers are fairly close together.

In 1948, it rained every day during the flowering period between June 7 and 13 with only 7% of the possible sunshine and 78 degree days. (U. S. Weather Bureau reports temperature variations in this way for the heating engineers, a degree day being the difference between 65° F. and the mean temperature for the day.) In 1949 there was no rain during this period, 85% of possible sunshine was available and it was warm, there being only 14 degree days. Two extremes in weather, yet because of wind pollination, fruiting was effective on certain plants both year, even though insect flight in 1948 must have been reduced to a minimum because of cold temperature and rain.

This is merely a progress report of these experiments to date, but it would seem that from the evidence, commercial growers would stop growing *Celastrus* indiscriminately from seed. Since they are easily rooted from soft or hardwood cuttings and easily budded, the fruiting of every plant sold could be insured by growing only pistillate plants from cuttings and budding on each plant one or two buds of the staminate plant. An adaptation of this could, of course, be used on other dioecious plants.

DONALD WYMAN

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